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The American Midland Naturalist

Devoted to Natural History, Primarily
that of the Prairie States

Founded by J. A. Nieuwland, C.S.C.

Contents

A Short History of Rhus to the Time of Linnaeus—*Fred A. Barkley* and *Elizabeth Ducker Barkley* 265

Plants of the Lava Beds National Monument, California—*Elmer I. Applegate* 334

Flora of Muskogee County, Oklahoma—*Elbert L. Little, Jr.* 369

Aceretum rubri: the Red Maple Swamp Forest of Central Long Island—*Stanley A. Cain* and *Wm. T. Penfound* 390

The Leaf and Stem Anatomy of Cornus florida in Relation to Light Exposure—*Claudine Kaps Shank* 417

Studies of Mexican and Central American Plants—V.—*C. L. Lundell* 427

A New Phlox from the Snake River Canyon, Idaho-Oregon—*Edgar T. Wherry* and *Lincoln Constance* 433

Bryophyta of Arctic America. I. Species from Little Diomede Island, Bering Strait, Alaska—*William Campbell Steere* 436

Studies on Larval Trematodes from Kentucky with a Summary of Known Related Species—*Raymond M. Cable* 440

New Species of Monogenetic Flukes from Illinois Fishes—*John D. Mizelle* 465

Movements and Mating Habits of the Sand Crab, Emerita analoga—*C. E. MacGinitie* 471

Brissopsis blanpiedi, a New Species of Echinoid from the Medial Tertiary of Mississippi—*U. S. Grant, IV.* and *L. G. Hertlein* 482

Book Reviews 487

Vol. 19 MARCH, 1938 No. 2

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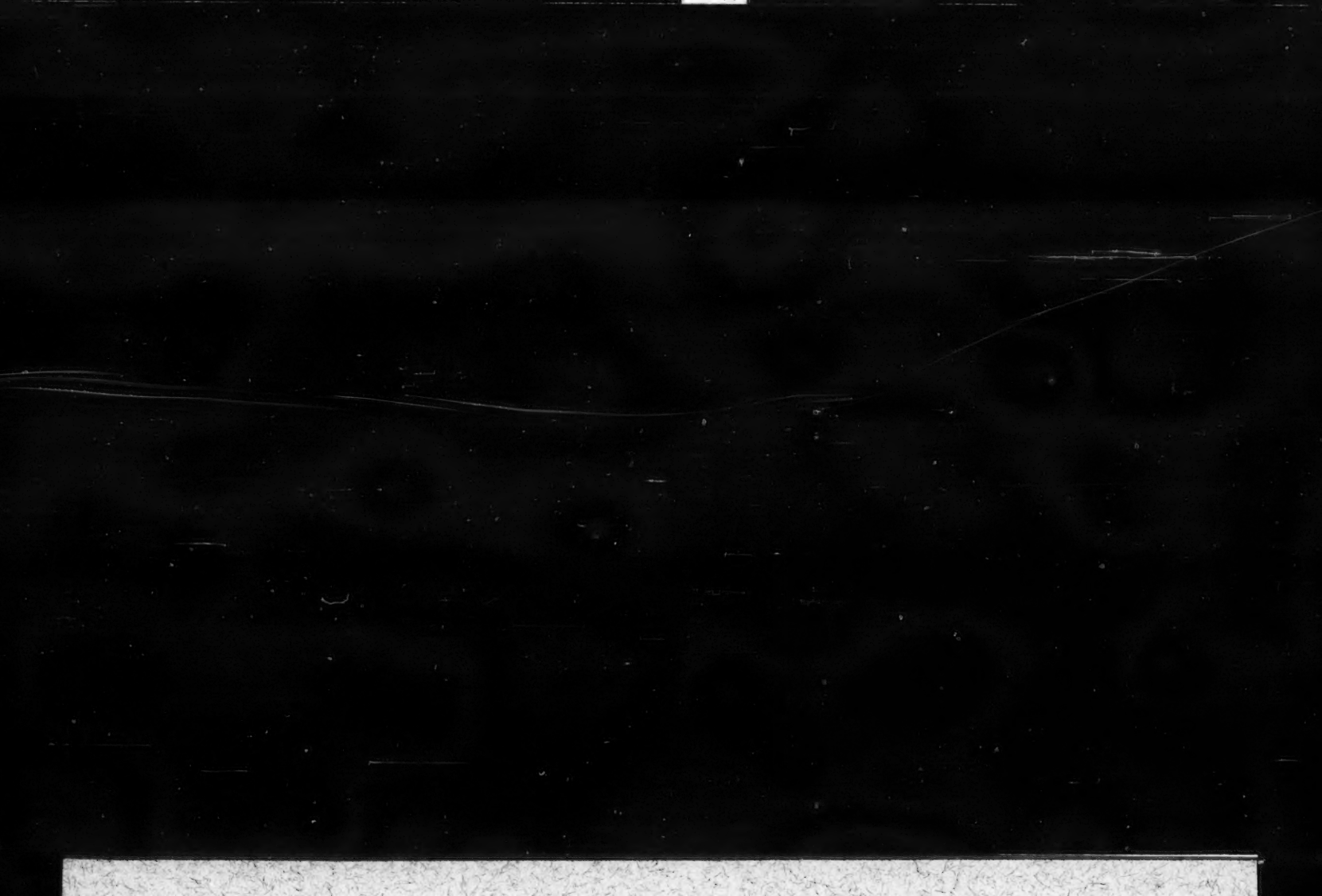

The American Midland Naturalist

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A Short History of Rhus to the Time of Linnaeus

Fred A. Barkley and Elizabeth Ducker Barkley

Ever since childhood when some old volumes came into their households, the authors have been fascinated by old books. The remarkable collection of rare old botanical treatises available in the Sturtevant Collection at "Shaw's Garden"[1] intensified this interest, which by that time had become a hobby, and directed it, also, to the study of herbals. However, it was only when it became necessary in the course of monographing *Rhus* to go into its early history that they really began to understand and appreciate the worth and interest of these old volumes. The idea then occurred that a history with protographic reproductions[2] showing the comparative treatment of one group by some of the more famous pre-Linnaean authors, might be of value. While the title 'brief history' might seem to be a misnomer, the authors would like to emphasize that no attempt has been made to cover systematically all pre-Linnaean botanical works, but to include those of general interest or those to which Linnaeus or his contemporaries particularly referred. To

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1 The Missouri Botanical Garden, St. Louis, Missouri.

2 The authors writing for an English speaking audience have limited their quotations for the most part to English works or English translations.

3 McNair, James B., (*The Taxonomy of Poison Ivy*. Field Museum of Natural History Botanical Series 4:55-56. 1925,) states that "The common English name, "sumach," is similar to the ancient Arabian "Sommaq" and the Byzantian σουμάκι, from which it is probably derived. The botanical name for the genus *Rhus* has a more obscure origin . . . Pliny says that *rhus* is from the Greek name for these trees, ῥοῦς, and the ῥοῦς has no Latin equivalent. . . Miller gives as a possible derivation its contraction from ῥόος, and from Greek the verb ῥέω "to flow," because certain products of the plant were formerly used to check hemorrhages. Boehmer suggests that the name is derived from the red color of the berries, from the word ῥόος, Latin *rufus* (red), or from ερυθρόν, Latin *rubrum* (red). Paxton gives as a possible origin the Celtic word "*rhudd*," or red, from the prevailing color of the autumn foliage, but the Celtic tribes were probably too far north to have influenced the derivation of the word *rhus*, as the plants mentioned by Theophrastus and Pliny were native to Asia Minor."

include here all early references to such a well-known and widespread group would make a compendium of monographic proportions.

Few genera of plants have so old and interesting a written history as does *Rhus*. Since Greek and Roman times *Rhus*[3] has been used in tanning, in pharmacy and in cooking. In the broadest sense, the genus is almost cosmopolitan in distribution and includes plants of great diversity, among which are poison oak and poison ivy, the sumacs, the smoke-tree, the hog-gum, and the American pictacia. In habit it varies from very small shrubs, as the poison oak (*Toxicodendron quericofolia* [Michx.] Dippel) and Carolina sumach (*Rhus Michauxii* Sarg.), through small trees as the Hog-gum (*Metropium Brownei* [Jacq.] Urb.), the smoke tree (*Cotinus Coggygria* Scop.), and Texas sumach (*Rhus lanceolata* [Gray] Engler), to trees as *Rhus Legati* Schonl., and *Toxicodendron succedanea* (L.) Kuntze. The leaves of different species vary from simple through trifoliate to pinnately many-foliate, and may be very thin in texture to very thick and leatherly. Many of the African and American species are trifoliolate. *Rhus microphylla* Engelm. of the American Southwest, has pinnately compound leaves often less than a centimeter long! *Cotinus Coggygria* Scop. has thin simple leaves. *Rhus ovata* Wats., *R. integrifolia* Benth & Hook., and *R. laurina* Nutt. all have thick leathery unifoliolate leaves. The variation among the leaves of various plants of the same species, such as *Toxicodendron radicans* (L.) Kuntze, *Rhus glabra* L., *R. dentata* Thunb., *R. MacOweni* Schonl., and *R. trilobata* Nutt., is almost without end.

Most of the poisonous species have a glabrous fruit covering, while many have a fine red glandular pubescence, and *Rhus potentillaefolia* Turcz. has long silky pubescence. With such a variety it is not at all surprising that various writers have treated the species in various ways, nor is one surprised that many plants, even non-Anacardiaceous,[4] were placed in *Rhus* during the period when new plants from Africa and the Americas were flooding the European herbaria. The various members of the Rhus complex in its broadest sense as treated by the pre-Linnaean and Linnaean writers are discussed on the following pages.

It is interesting to note in passing that all the criteria for the determination of generic types which apply in the case of *Rhus*, all concur in the placing of *R. Coriaria* L.[5] as the type. This species, which is a common shrub of the Mediterranean region, evidently was well known to the early Greeks, for

4 To conserve space, it has seemed best for the most part, to omit mention of the plants erroneously placed in *Rhus* by these early authors.

5 For the meaning of *Coriaria* we quote Cole in *Adam in Eden*, "because the Coriers use it about their leather." *Coriarius*, Lat., leather-dresser; *corium*, Lat., hide; *coriare*, Fr., tanner's sumac; *courroyeur*, Fr., leather-worker; *courier*, Eng., leather-worker.

Theophrastus in his *Enquiry into Plants,* quoting from Sir Arthur Hort's English translation,[6] states:

Of the sumach they recognise a 'male' and a 'female' form, the former being barren, the latter fruit-bearing. The branches are not lofty nor stout, the leaf is like that of the elm, but small more oblong and hairy. On the young shoots the leaves grow in pairs at equal distances apart, corresponding to each other on the two sides, so that they are in regular rows. Tanners use this tree for dyeing white leather. The flower is white and grows in clusters; the general form of it, with the branchlets, is like that of the grape-bunch; when the flowering is over, the fruit reddens like the grape, and the appearance of it is like small lentils set close together; the form of these too is clustering. The fruit contains the drug called by the same name, which is a bony substance; it is often still found even when the fruit has been put through a sieve. The root is shallow and single, so that these trees are easily bent right over, root and all. The wood has heart-wood, and it readily perishes and gets worm-eaten. The tree occurs in all regions, but flourishes most in clayey soils.

Dioscorides in his *Greek Herbal,* discussed *R. Coriaria* rather fully in a manner remindful of some of the modern popular cures. Quoting from John Goodyer's English Translation, Dioscorides[7] says:

Rhus which is sprinckled amongst sawces, and which somme call Erythrum, is the fruit of that which is called *Rhus Coriaria,* which is soe called, because Tanners doe use it for ye thickning of their hydes. It is but a little tree growing upon rocks, as it were two cubits high, on which ye leaves are somewhat long, somewhat red, jagged round about; but the fruit is like to a little bunches of grapes, thick according to ye begnesse of ye Terebinth, somewhat broad, of which that which compasseth ye fruit about is very usefull. The leaves have a binding facultie, good for ye same purposes that Acacia is. The decoction dyes ye hair black, and it is glister for Dysenteries, and a potion, and an insession, and an instillation of matterie eares: the leaves being layd on as a Cataplasme, with Vinegar or Hony, doe stay Pterygia, and Grangraens. And ye yuice of ye dryd leaves, being sod with water, to ye consistence of Hony are availeable for as many thinges as Lycium is. And ye fruit likewise doth doe ye same things, being food, in mixing it with ye meate for ye Coeliaci, and Dysenterici, being applyed as a Cataplasme with water, it keeps from inflammation, fractures, desquamations or peelings, blewnesse of wounds. It cleanseth the roughness of ye tongue with Hony. It staies ye flux called ye whites, and cures ye Haemorrhoids being layd on with Oaken coales beaten small. And ye liquor of this being sod gathers a creame, being better for the sayd purposes than ye fruit. It leaves also a gumme, which is put into ye Concavities of teeth to take away their paine.

As is usual in Pliny's *Natural History*[8], we find a summary of the discussions of Theophrastus and Dioscorides; that of *R. Coriaria,* with a few minor changes and additions from the writings of those authors such as the ascription to the male as bearing fruit and to the lack of a Latin name is herewith quoted:

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6 Book 3. Of wild Trees: Of the differences in various shrubs—buchthorn, withy, Christ's thorn, bramble, sumach, ivy, smilax, (spindle-tree) *paragraph 5.*

7 Book 1. Aromatics, Oils, Ointments, Trees. 147. Rous. Rhus Coriaria. Tanning Sumach.

8 Philomon Holland's English Translation. The first paragraph from chapter six of book thirteen; the second paragraph from chapter eleven of book twenty-four. (x .55 of the original.)

C Alſo the male Rhus or Sumach of Syria doth beare fruit: wheras the female is barren. This plant putteth forth leaues like to the Elme, but that they be ſomewhat longer, and ful of hairs, and euermore the ſteles of the leaues grow contrary one againſt the other. As for the branches, they be ſlender and ſhort, good for curriers to dreſſe their skins and make leather white. The ſeed or graine thereof reſembles Lentils: and being ripe, it is red, and commonly with the grape. The which is called Rhus or Sumach, euen as the tree: a neceſſarie fruit for many medicines.

Neither hath Rhus a Latine name, notwithſtanding it be much vſed in Phyſick, & otherwiſe. For it is a wild plant growing of it ſelf, bearing leaues like vnto the Myrtle, vpon ſhort ſtalkes and branches; ſingular for to expell any poiſon and worms out of the body: and beſides, called it is, the Curriers ſhrub, for that they vſe to dreſſe their skins with the dry leaues therof, inſtead of pomgranat rinds. Of a reddiſh colour it is, a cubit in height, & a finger thick. Moreouer, Phyſitians imploy the medicins wherinto this Rhus is put, for bruiſes: likewiſe, for the flux proceeding from a feeble ſtomack, as alſo for the vlcers in the ſeat. But the leaues ſtamped and incorporat with hony, and ſo brought into a liniment or ſalue with vineger, do heale cankerous ſores ſuch as with inflammation do eat away the fleſh to the very bone. Their decoction is ſingular to be inſtilled into the ears that run with filthie matter. Moreouer, there is made a ſtomaticall compoſition of the branches of this Rhus, boiled, which ſerueth in the ſame caſes as the abouenamed Diamoron, ſ. of the Mulberries: but if it haue allum ioined withall, it is of greater efficacy. The ſame being brought into a liniment, is paſſing good for the ſwellings in a dropſie. As for the * Rhus, which is called Erythros, ſ. the red, it is a ſhrub, and the ſeed thereof is both aſtringent and refrigeratiue. Much vſed is the grain or ſeed of this Rhus in ſtead of ſalt to pouder & ſeaſon meats. Laxatiue it is, and giueth a pleaſant taſt to any fleſh meats, eſpecially if Silphium be mingled withal: tempered with hony, it cureth and healeth all running vlcers: and in that maner prepared, it is excellent for the roughnes of a furred tongue, for places bruiſed, looking black & blew, or otherwiſe raw where the skin is raſed & pilled off. Nothing ſo ſoon healeth any wounds in the head, and bringeth them ſo quickly to cicatrice. And taken inwardly with other meats, it ſtoppeth the immoderat flux of womens fleurs.

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* This kitchin Rhus or meat-Sumach, is all one with the other: but that the cocks vſed the ſeed, and the curriers occupied the leaues and the branches.

Pliny's treatment is the basis of the Renaissance writings on *Rhus*, as may be noted from subsequent quotations.

The only other member of the *Rhus complex* known in ancient times was *Cotinus*, of which *Theophrastus*[9] says:

The leaf of the wig-tree is also like that of the last named tree, but it is a small tree. Peculiar to it is the fact that the fruit passes into down: we have not heard of such a thing in any other tree. These trees are found in a good many positions and regions.

Pliny[10] disposes of *Cotinus* even more briefly, as follows:

Upon the great hill Apennine there is a shrub named Cotinus, with a red or purple wood, most excellent for in-laid works in marquetry.

Another reference to *Rhus*, which *appeared* soon after the invention of the printing press in *Gart der Gesundheit*, printed in Augsberg in 1487, and ascribed to the pen of Hannsen Schönsperger, is:

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9 Hort's English translation, see bibliography. Book 3. Of Wild Trees; of certain other oaks, arbutus, andrachne, wig-tree, *paragraph* 6b.

10 Holland's English translation, see bibliography. From chapter eighteen of book fifteen.

ein lame von einem baum also genant Das cccxci Ca

Sumach latine·greece rißkitun· arabice barso·

¶ Die meyſter ſprechendt·das diſes ſey kalt in dem zweyten grad·vnd trucken an dem dritten· Diſes iſt ein kraut vñ wechßet geren bey den felhē· Dz beſte von diſem baume daz iſt die rynden von dem ſamen als Galienus ſpricht· ¶ Diſe rindē vō dem ſamen ſol man bulferiſierē vnnd das ein nemen mitt dem ſafft e ſanguinaria ſiue centum nodia · es ſtillet zůhandt alles blůten in der naſen oder in den wunden ¶ Die do blůtſpeyend vō groſſer feüchtung die ſy haben vmb die bruſt die ſöllen nützen pillulen gemachet von Sumach vñ von gūmi arabicum vnd roſenwaſſer· vñ der nützē ein quintin· ¶ Für daz grymen in dem bauch ſol man nemē ſumach vnd gerſten mele vnd dz ſieden in regen waſſer vñ diſes vnden ein nemen gleich einem klyſtier es hilffet·

Of Coriars Sumach.

Fig. 1. Rhus Coriaria, Coriars Sumach (*R. Coriaria* L.) from *The Herball* by John Gerarde. p. 1290. 1597. x .6 of the original.

(x .9)

The *antidotoria*, or herbals of classical and medieval time and the Renaissance, which were the writings of individuals and varied quite considerably, lead directly to the requirement in 1529, by the city of Nürnberg of an official herbal. The *Dispensatorium* of Valerius Cordus was adopted by Nürnberg, and probably first printed about 1551,[11] with the requirement that the druggists of Nürnberg prepare their medicines according to it.[11a] *Rhus Coriaria* is the only species of *Rhus* listed by Cordus. The two short references to this plant, given under 'Confectiones Opiate' of the 'Tituli Dispensatorii *(sic)*,' are:

Rhois culinari (id est, obsoniorum).

RHVS Culinarium, id est, quod nunc vocant Arabico nomine Sumach: opportet autem enucleatum, & pulpa maius accipere.

Auxilio est coelia cis, dysentericis, lenitati intestinorum, alui profluvio cum aqua caelesti, in quoa spodium inferbuerit, aut suo cimun torrefactum, vel cum stillaticio rosarum liquor.

RHOIS Culinarij, id est Sumach, videlicet pulpae eius sine osseus seminibus.

The herbal which appeared under the title of *The Herball or General Historie of Plants Gathered by John Gerarde of London Master of Chirurgerie* in 1597, contained discussions on "The Coriars Sumach" (Fig. 1), "Venice Sumach and Red Sumach" (Figs. 2 and 3), and the Myrtle or so-called "Rhus Plinie." The discussion of *Rhus* from this work[12] (pages 1292-1294) follows:

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11 The first quotation from pages 98-99, and the second from page 143, of the 1575 Lugduni (Lyons) edition, which the authors consulted in the library of the New York Botanical Garden. An earlier edition, 1556 Venetiis Venice), which was seen in the Surgeon General's Library in Washington, D.C., differed only slightly from this edition. There is considerable variation in the dates ascribed to the various editions of this work. According to Pritzel's *Thesaurus Literaturae Botanicae*, edition one was the 1551 Lugduni edition, but according to Arbor's *Herbals*, 1546.

11a This formulary thus became the first official Pharmacopoeia, which was soon followed by the adoption of official formularies by other cities. Later with the rise of nationalism, national Pharmacopoeias replaced those of cities.

12 This is said to be based on Dr. Priest's English translation of Dodoen's *Pemptades*, much improved by Gerarde, but unfortunately denying any credit to Dr. Priest. (Reproduced x .65 of the original.)

The deſcription.

1 COtiars Sumach groweth vp vnto the height of a hedge tree, after the maner of the Elder tree; bigger then *Dioſcorides* reporteth it to be, or other, who affirme that *Rhus* groweth two cubits high; whoſe errors are the greater: but this *Rhus* is ſo like vnto the Seruice tree in ſhape and maner of growing, that it is hard to know one from the other; but that the leaues are ſoft and hairie, hauing a red ſinewe or rib thorow the midſt of the leafe: the flowers growe with the leaues vpon long ſtems cluſtering togither like cats taile, or the catkins of the nut tree, but greater, and of a whitiſh greene colour: after which come cluſters of rounde berries, growing in bunches like grapes.

2 *Plinie* his Sumach, or the Sumach of *Plinies* deſcription, groweth like a ſmall hedge tree, hauing many ſlender twiggie branches, garniſhed with little leaues like *Myrtus*, or rather like the leaues of the *Iuiube* tree; among which come foorth ſlender moſſie flowers, of no great account or value, which bring forth ſmal ſeeds, incloſed within a cornered caſe or huske, faſhioned like a ſpoone: the trunke or body of both theſe kinds of Sumach being wounded with ſome iron inſtrument, yeeldeth a gum or liquor.

The place.

Sumach groweth as *Dioſcorides* ſaith, in ſtony places: it is found in diuers mountaines and woods in Spaine, and in many places on the mount Apennine in Italy, and alſo neere vnto Pontus. *Archigenes* in *Galen* in the 8. booke of medicines according to the places affected, ſheweth that it groweth in Syria, making choice of that of Syria.

The time.

The flowers of Sumach come foorth in Iuly, the ſeed with the berries are ripe in Autumne.

The names.

This is called in Greeke [illegible] *Rhus* ſaith *Plinie* hath no Latine name; yet *Gaza* after the ſignification of the Greeke worde, ſaineth a name, calling it *Fluida*: the Arabians name it *Sumach*: the Italians *Somacho*: the Spaniards *Sumagre*: in low Dutch by contracting of the word they call it Smack, or Sumach: in Engliſh Sumach, Coriars Sumach, and leather Sumach: the leaues of the ſhrub be called [illegible]: in Latine *Rhus coriaria*, or *Rhoe*.

The ſeede is named [illegible] and [illegible] in Latine *Rhoe culinaria*, and *Rhoë obſonierum*: in Engliſh Meate Sumach, and Sauce Sumach.

The temperature.

The fruit, leaues, and ſeede hereof do very much binde, they alſo coole and drie: drie they are in the third degree, and cold in the ſecond, as *Galen* teacheth.

The vertues.

A The leaues of Sumach boyled in wine and drunken, do ſtop the laske, the inordinate courſe of womens ſickneſſes, and all other inordinate iſſues of blood.

B The ſeede of Sumach eaten in ſauces with meate, ſtoppeth all manner of fluxes of the belly, the bloodie flixe, and all other iſſues, eſpecially the white iſſues of women.

C The decoction of the leaues maketh haires blacke, and is put into ſtooles to fume vpward into the bodies of thoſe that haue the dyſenterie, and is to be giuen them alſo in drinke.

D The leaues made into an oyntment or plaiſter with honie and vineger, ſtaieth the ſpreading nature of *Gangræna* and *Pterygium*.

E The drie leaues ſodden in water vntill the decoction be as thicke as honie, yeeldeth foorth a certaine oylineſſe, which performeth all the effects of *Licium*.

F The ſeede is no leſſe effectuall to be ſtrowed in powder vpon their meates which are *Caliaci* or *Dyſenterici*.

G The ſeeds pouned, mixed with honie and the powder of Oken coles, healeth the Hemorrhoides.

H There iſſueth out of the ſhrub a gum, which being put into the hollowneſſe of the teeth, taketh away the paine, as *Dioſcorides* writeth.

Of red Sumach. Chap.106.

The deſcription.

1 THeſe two figures are one and the ſelfeſame plant, the firſt ſheweth the ſhrub being in flower: the other when it is full flowred with the fruit growen to ripeneſſe, notwithſtanding ſome haue deemed them to be of two kindes, wherein they were deceiued.

This excellent and moſt beautifull plant *Coggygria*(being reputed of the Italians and the Venetians for a kinde of *Rhus* or Sumach, becauſe it is vſed for the ſame purpoſes whereto *Rhus* ſerueth and therein doth far excell it) is an hedge plant growing not aboue the height of fower or fiue cubits, hauing tough and pliant ſtalks and twiggie branches like vnto Oziers, of a browne colour. The leaues be round, thicke and ſtuffe like the leaues of *Capparis*, in colour and ſauour of *Piſtacia* leaues, or *Terebinthus*; among which ariſeth a ſmall vpright ſprig, bearing at the toppe a moſt fine woollie or flockie tuft, criſped and curled like a curious wrought ſilken fleece, which curleth and foldeth it ſelfe abroad like a large buſh of haires, cõpact of red or crimſon coloured haires; amongſt which commeth foorth the ſeede, much like vnto *Lens*, but ſmaller, and of a darke red colour.

1 *Coggygria Theophraſti* Venice Sumach. 2 *Cotinus Coriarius Plinij.* Red Sumach.

* *The place.*

Coggygria groweth in Orleanſneere Aunion, and in diuers places of Italie, vpon the Alpes of Hiſtria, and many other places. It groweth on moſt of the hils of France, in the high woods of the vpper Pannonia or Auſtria, and alſo of Hungaria and Bohemia.

* *The time.*

They flower and flourith for the moſt part in July.

* *The names.*

The firſt is called *Coggygria* and *Cocygria*: in Engliſh Venice Sumach, or Silken Sumach; of *Plinie Cotinus* in his ſixteenth booke eighteenth chapter. There is (ſaith he) on mount Apennine a ſhrub, which is called *Cotinus ad lineamenta mollis Conchylij colore inſignis*, and yet *cotinus* is *Oleaſter*, or *Olea ſilueſtris*, the wilde Oliue tree, from which this ſhrub doth much differ; and therefore it may rightly be called *Cotinus Coriaria*: diuers would haue it named *Scetinus*, which name is not found in any of the olde writers. The Pannonians do call it *Farbſtuff*. It is alſo thought that this ſhrub is *Coggygria Plinij*, of which in his 13. booke 22. chapter he writeth in theſe words, *Coggygria* is alſo like to *Fraxino* in leafe, not ſo great; it hath a propertie to loſe the fruit by the downe, which thing happeneth to no other tree.

* *The temperature.*

The leaues and ſlender branches together with the ſeedes, are very much binding, cold and drie as the other kindes of Sumach are.

* *The vertues.*

The leaues of *Coggygria*, or ſilken Sumach, are ſold in the markets of Spaine and Italie for great ſummes of money, vnto thoſe that dreſſe Spaniſh skins, for which purpoſe they are very excellent.

The roote of *Cotinus*, as *Anguillara* noteth, ſetteth to the with, giuing to wooll and cloth a reddith colour, which *Plinie* knew, ſhewing that this ſhrub (that is to ſay, the roote) is *ad lineamenta mollia Conchylij colore inſignis.*

Fig. 2. Coggygria Theophrasti, Venice Sumach (*Cotinus Coggygria* Scop.) from *The Herball* by John Gerarde. p. 1293. 1597. x .5 of the original.

Fig. 3. Cotinus Coriarius Plinij. Red Sumach (*C. Coggygria* Scop.) from *The Herball* by John Gerarde. p. 1293. 1597. x .5 of the original.

Most of the earlier herbalists were merely philological commentators who knew little, if anything of plants from original observation. To most of these herbalists the plants themselves were regarded mainly as vehicles of medicinal virtues, as ingredients in compound medicine. The later herbalists went straight to nature to describe and figure wild plants. *Rhus Coriaria* and *Cotinus Coggygria* are the only members of the genus known botanically before 1600. Both are found in Andrea Caesalpini *De Plantis*, and are illustrated in the works of Rembertus Dodonaeus (Figs. 4, 5 and 10), Achimus Camerarius (Figs. 7 and 11), and Matthias L'Obel[13] (Figs' 8 and 9), but only *Rhus Coriaria* is mentioned in Castore Durante's *Hortulus Sanitatis* (Fig. 12). In fact, most of the herbal of this period mentions one or both, except those of such workers as Fuchs, who records only first-hand information.

In 1620, a North American species, *Rhus glabra*, was described as *Sumach angustifolium* in Casper Bauhin's *Prodromus*, where the habitat was incorrectly given as Brazil. This plant was again mentioned three years later in the same author's *Pinax* as *Rhus angustifolium*, along with[14] *R. Coriaria* (there called *Rhus folio ulmi*), *R. typhina* (called *Rhus Virginiana* and there described for the first time), and *Cotinus Coggygria* (as *Cocconilea* or *Coggygria*).

Captain John Smith is given credit[15] for first mentioning poison ivy, noting that it differed little in appearance from English "yvie," and stating that it "causeth rednesse, itchynge, and finally blysters," but that if let alone the ailment presently goes away of itself.

The first appearance of what is now known as *Toxicodendron radicans* (L.) Kuntze was in Cornutus' *Canadensium Plantarum* where it is described and figured (Fig. 18) as *Edera trifolia canadensis*.

John Parkinson in his *Theatrum Botanicum* of 1640 gives an interesting summary[16] of the knowledge of sumacs of his time:

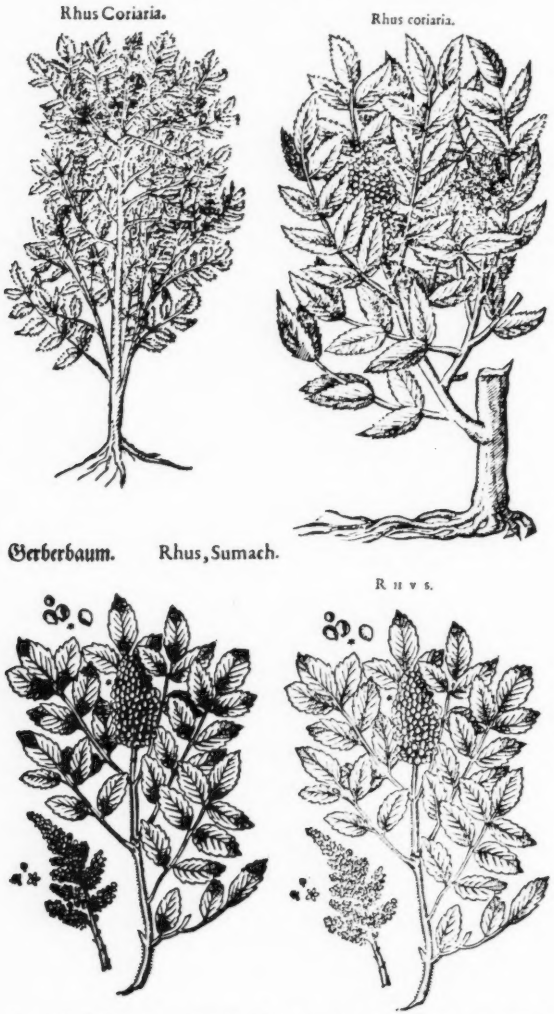
---

13 Or Lobel.

14 Bauhin also lists *Rhus myrtifolia Monspiliaca* and *Rhus myrtifolia Belgica*, an error followed by the majority of authors before the time of Linnaeus.

15 Thone, Frank. Science: June 5, 1936, New Series **83**: no 2162; Science News.

16 The quotation here given omits reference to numbers 3 and 5, *Rhus Plinij Mirtifolia*, the 'mirtle leafed Sumacke,' and *Rhus sylvestris sive Myrtus Brabaeantica aut Anglica*, the 'Sweet Gaule,' respectively. The quotation is taken from chapter XLIV, Sumach sive Rhus, Sumacke (pages 1449-1452). (x .55 of the original.)



Figs. 4-7. (4) Rhus Coriaria (*R. Coriaria* L.) from Lyte's English edition of Rembert Dodoens' *A nievve herball*. p. 692. 1758. (5) Rhus coriaria (*R. Coriaria* L.) from Rembert Dodoens' *Stirpium Historiae*. p. 767. 1583. Compare with figures 8 and 16. (6)Gerberbaum, Rhus, Sumach (*R. Coriaria* L.) from Matthiolus' *Kreuterbuch*. p. 68. 1586. Compare with figures 7, 12, and 13. (7) Rhus (*R. Coriaria* L.) from Camerarius' *Deplantis*. p. 121. 1584. (x .6).

In *Theatrum Botanicum* (page 1524) Parkinson also gives what is probably the first description of *Rhus Copallina* L. under the title of *Lentisci Pecuani Similia Molle Dicta.* In still other places (pages 697 and 1556), under the titles of *Hedera trifolia Virginensis* and *Vitis Sylvestris trifolia Canadensis,* he describes what is now known as *Toxicodendron quercifolia* (Michx.) Greene.

During the period of the Renaissance there arose two superstitions connected with pharmaceutical botany, Astrological Botany and the Doctrine of Signatures. Astrological botany being rather complicated and more incredible, was not widely accepted, but the Doctrine of Signatures gained a firm hold. This theory merely held that all plants were created in such a form that their uses were indicated; therefore the botanist's most important function was to

Fig. 8. Rhus obsoniorum and Coriariorum (*R. Coriaria* L.) from Lobelius' *Icones Stirpium.* Vol. 2. p. 98. 1591. (x .78).

Fig. 9. Coccygria Theophrasti (*Cotinus Coggygria* Scop.) from Lobelius' *Icones Stirpium.* Vol. 2. p. 99. 1591. Compare with figure 14. (x .78).

Figs. 10-13. (10) Cotinus coriaria (*C. Coggygria* Scop.) from Rembert Dodoens' *Stirpium Historiae*. p. 758. 1583. (11) Cotinus (*C. Coggygria* Scop.) from Camerarius' *Deplantis*. p. 123. 1584. (12) Gerberbaum, Rhus Sumach (*R. Coriaria* L.) from Castore Durante's *Hortulus Sanitatis*. p. 847. 1609. (13) A portion of page 146 of Zwinger's *Theatrum Botanicum* (1694) showing Gerberbaum, Rhus (*R. Coriaria* L.) (x .6).

Sumach sive Rhus. Sumacke.

THere are three or foure sorts of Sumacke to shew you, three of them of ancient knowledge and use, but one other of later invention: whereunto I must adjoyne another plant, which both for the names sake, and some likenesse thereunto, hath caused divers learned men to intitle it by their name.

1. *Sumach sive Rhus obsoniorum & coriariorum.* Coriars Sumacke.

The Coriars Sumacke in some places riseth to be a reasonable great tree (but in dry barren grounds not above two or three cubits high, or where it is yearely or every other yeare pruined for the profit made of them) spreading sundry branches with large winged leaves, that is many set on both sides of a middle ribbe, each of them dented about the edges, *Theophrastus* compareth them to Elme leaves, but lesser and longer, and *Dioscorides* to the leaves of the *Ilex*: at the ends of the branches come forth large spiked clusters of whitish flowers, which afterwards become reddish, round and flat seede like unto Lentils, with an outward skinny huske, which was, and is yet still in divers places in *Turky*, the condiment or seasoning for meate, being dryed and made into pouther: the wood is whitish, which being dryed and ground serveth to dye blacke withall, as is well knowne to most.

2. *Sumach sive Rhus Virginiana. Virginian* Sumacke.

The *Virginian* Sumacke groweth up in some places to be a tree of a meane size whose barke on the body and elder armes is rugged, and of a darke russet colour, those that are two or three yeare old, are smooth and not rugged, but those of the last yeare are of the same brownish red colour and softnesse, that the new velvet head of a deare sheweth to have, (that it might deceive a right good Woodman to see one cut of and presented him on the suddaine, yeelding a yellowish milke, when it is broken or wounded, which in a small time becommeth thicke like unto a gumme: the long winged leaves grow one above another on both sides of the branches very largely spread, having eight or tenne or more long narrow leaves set on each side of a middle ribbe, and one at the end, very smally dented about the edges, of a darke greene shining colour on the upper side, and paler greene underneath: at the ends of the branches come forth long and thicke browne tufts or heads, very soft and woolly in handling, made all of short threds or thumbes, from among which appeare many small flowers much more red or crimson then the tufts, which turne into a number of very red round flattish seede, thicke and close, set on the branches of the head together, lesser then the small Lentils, having a small blackish seede, under that outward skinny huske, whose shell is somewhat hard, enclosing a white kernell within it. the roote spreadeth much under ground, shooting forth suckers round about, and a good way off from the body of the tree.

4. *Coggygria sive Cotinus Coriaria.* Venice Sumacke.

4. *Coggygria sive Cotinus Coriaria.*
Venice Sumacke.

The *Venice* Sumacke is in some places a tree, rising to be of the bignesse of the Pomegarnet tree, in other places it is much lower, and shooteth forth many twigges, of two or three cubits long, and of the bignesse of ones finger, divided into many reddish branches, having sundry leaves set on both sides without order, somewhat broad, round pointed, thicke, and full of veines, and small red footestalkes under them, a little waved about the edges, of a Rosenlike sent, not unpleasant, and of an harsh binding taste, growing to be of an excellent Rose colour, in the end of Summer; from the ends of the branches start forth a large and long head, consisting of many tufts, of whitish greene flowers, standing upon very fine red footestalkes, which afterwards spread themselves into so many tufts of feather-like haires or threds, having among them sundry small blackish and flat seede, formed somewhat like unto an heart, which together with the silken threds are carried away by the winde: the roote is hard and wooddy, not growing deep nor much spreading: the wood is yellowish, and serveth to give a yellow dye: but the

Fig. 14. Coccygria sive Cotinus coriaria, Venice Sumacke (*C. Coggygria* Scop.) from Parkinson's *Theatrum Botanicum*. p. 1451. 1640. (Note that this figure, which is reproduced with the quotation on page 1450, occurred in the original on page 1451.) x .6 of the original.

leaves and young branches, doe Dye a blacke colour; and with the barke they Tanne leather, as with the other.

.....

The Place and Time.

The firſt groweth in *Syria* and *Pontus*, as *Galen* ſaith; in *Italy* and *Spaine* as *Pliny* ſaith, and in divers other places, where it is manured as carefully as their Vines, and as *Cluſius* ſaith he ſaw it ſo ordered in *Spaine*, which yeelded the Owners great profit, the ſecond groweth naturally in *Virginia*, from whence we had it. ..... The fourth in *Savoy*, and on the *Appenine* hils and elſewhere. ....

.....

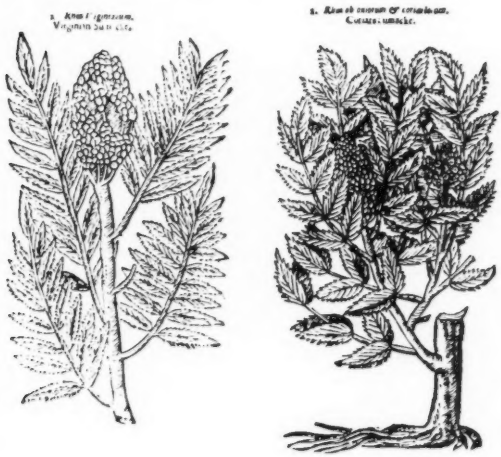
The Names.

It is called in Greeke ῥοὴ, and by *Hippocrates* ῥοῦς, in Latine alſo *Rhus*, for *Pliny* ſaith it hath no Latine name although *Gaza* calleth it *Fluida* ſuppoſing the name to be derived from *fluo*, but it is rather a *rubore vel colore coccineo acinorum*, and therefore it was called ῥοὴ, from whence the Latine *Ruſſus*, as the *French Roux* came. It is called *Rhus* ſimply by ſome, as *Matthiolus &c. Rhus coriaria* by *Dod næus*, and *Rhus obſoniorum* by *Lobel*, *Camerarius*, *Cluſius*, and others, and *Sumach* both by ſhops and in *Rauwolfius*, or *Sumach Arabum*, becauſe it was called *Rhus Syriaca* by ſome, it was thought to differ from the former, as alſo, that *Rhus culinaria* and *coriaria* or *rubra*, did differ one from another, and were ſeverall ſorts, but *Paulus Ægineta*, doth plainly ſhew that the ſeede and juyce of *Rhus coriaria* was uſed by Phyſitions: another errour *Colon* ſhewed, that tooke the *Rhus Syriaca* to be *Res Syriaca*, a kinde of *Manna*, and therefore called it *rorem Syriacum*, inſtead of *Rhoem Syriacum*, and *rorem ſatorium* for *Rhoen Syriacum*, or *coriariorum*, not *ſatorum*, as it is in *Columella*: neither ſhould it be *Ros marinus*, but *Rhus marinus*, or *Rhus Orientalis* in *Marcellus* who appointeth it for diſenteries and the like. The ſecond hath not beene ſet out by any before me, onely *Bauhinus* ſeemeth to touch upon it, calling it *Rhus anguſtifolium*, ſaying it was brought out from *Braſile*. .....

the fourth is the ῥοιοδενδρὰς of *Theophraſtus*, which *Gaza* tranſlateth *Prunus*, but ſhould be rather *malus punica*, which ſheweth that *Gaza* was ſlenderly adviſed to give the word ſuch a name that a Plumme ſhould beare a ſeede to be caryed away with the winde, *Pliny* calleth it *Coccygeria*, or *Coccygria*, yet ſome have it *Cacygeria*: ſome alſo thinke it to be the *Cotinus Plinij*, and for a diſtinction betweene it and the *Oleaſter*, which is called *Cotinus* alſo, they call this *Cotinus coriaria Plinij*, in imitation whereof as it is thought, thoſe that dwell at the toppes of the *Apennine* hilts doe call it *Scotano*, and thoſe at the foote *Roſſolo*, of the red colour of the barke, and not of the Dye as ſome thinke becauſe *Pliny* ſaith, his *Cotinus* is, *ad lineamenta modo conchylij colore inſignem*, for this as is before ſaid, giveth a yellow colour. The *Savoyens* call the wood hereof which they loppe and fell for that purpoſe *Faſſet*, and we Fuſticke, which all Dyers know is of eſpeciall uſe with them, both the old wood to give one yellow colour, and the young another. *Matthiolus*, *Anguillara*, *Camerarius*, and *Geſner* in *hortis* call it *Cotinus*, yet *Geſner* alſo calleth it *Coccigia ſorte Barba Iouis Plinij*. *Dodonæus Cotinus Coriaria*, *Coccygeria* by *Cluſius* and others, and of *Caſalpinus Scotanum vulgo*, as the common people did. ..... The *Arabians* call the firſt *Sumac*, *Aduruc*, *Roſbar*, *Sadiſticos*, or *Roſadicos*, the *Italians Rhu* and *Sumaco*, the *Spaniards Sumach* and *Sumagre*, the *French Sumac*, the *Germanes Gerberbaum*, the *Dutch Sumack* and *Smack*. and we in *Engliſh* Sumacke and red Sumacke. .....

The Vertues.

Sumacke both leaves and ſeedes, and the medicines made of them are cooling in the ſecond degree, and drying in the third, the leaves of the firſt Sumacke have an aſtringent quality, that they may ſerve inſtead of *Acacia*, for thoſe purpoſes it is uſed, he decoctions of the leaves and ſeede is ſingular good for all ſorts of fluxes in man or woman, to take them in broth, or in meate or drinke, and to ſit in the decoction while it is warme as the bloody flix, the flux of the ſtomacke, womens courſes, and the whites alſo, to be drunke or inverted by gliſters or otherwiſe, or in bathes, it ſtayeth the ſtomacke that is much given to calling, the decoction of the leaves or ſeede made with vinegar, and a little honey put thereto is good againſt Gangrens or Cankers, the juyce that is taken out of the dryed leaves by boyling them in water and after they be ſtrayned to boyle them againe with ſome honey, hath the ſame properties that *Lycium* hath, the ſame helpeth the roughneſſe of the tongue and throate: the ſeede likewiſe boyled in water, and the decoction thereof evaporated to the thickeneſſe of honey, is more effectuall then the ſeede it ſelfe: the decoction of the greene leaves maketh the haire blacke to be waſhed therewith: the juyce of them dropped into the eares dryeth up the moiſture and running of them: the ſeede beaten and boyled into a pultis and applyed to any inflammation or hot Impoſtume, cooleth them much, and doth alſo take away the markes and paines of bruiſes and blowes, as alſo the frettings and gallings of the skinne. the ſame alſo helpeth the hemorrhoides or piles when they bleede too much, if it be applyed with the fine pouther of Oken coales: it is ſingular good alſo to be applyed to ruptures, both inwardly and outwardly, and to ſtay defluxions of hot and ſharpe rheumes into the eyes, and *Damocrates* uſed it in a medicine with Poppy heads, againſt diſtillations from the head, and againſt want of ſleepe: the gum that is found oftentimes iſſuing out of the tree, is good for hollow teeth, to eaſe the paines, and the decoction of the ſeede is good to waſh the mouth both to faſten looſe teeth, and to heale putrid and rotten gummes. What the *Virginia* Sumacke will performe, I have not knowne any hath made the proofe, but it is probable it might worke ſome of theſe effects if any would make the tryall. Both the Myrtle leafed Sumacke and the *Venice*, are in a manner as effectuall to all the purpoſes aforeſaid, excepe that they are a little weaker. The Gaule is by the bitterneſſe and harſhneſſe found to be both drying and diſcuſſing, and is very effectuall to kill the wormes in the belly or ſtomacke: it mightily affecteth the braine, cauſing firſt perturbations and then ſopiting the ſences: it is much uſed to be laid in Wardrobes, Cheſts, Preſſes, and the like, to keepe mothes from garments, and woollen cloathes as alſo to give them a good ſent.



Figs. 15-17. (15) Rhus Virginianum, Virginian Sumacke (*R. typhina* Torn.) from Parkinson's *Theatrum Botanicum*. p. 4150. 1640. x .5 of the original. (16) Rhus obsoniorum & coriariorum, Coriars Sumacke (*R. Coriaria* L.) from Parkinson's *Theatrum Botanicum*. p. 1450. 1640. x .5 of the original. (17) Sumach (*Rhus Coriaria* L.) from Lonicerus' *Vollständiges Kräuter-Buch*. p. 133. 1737. (x .65).

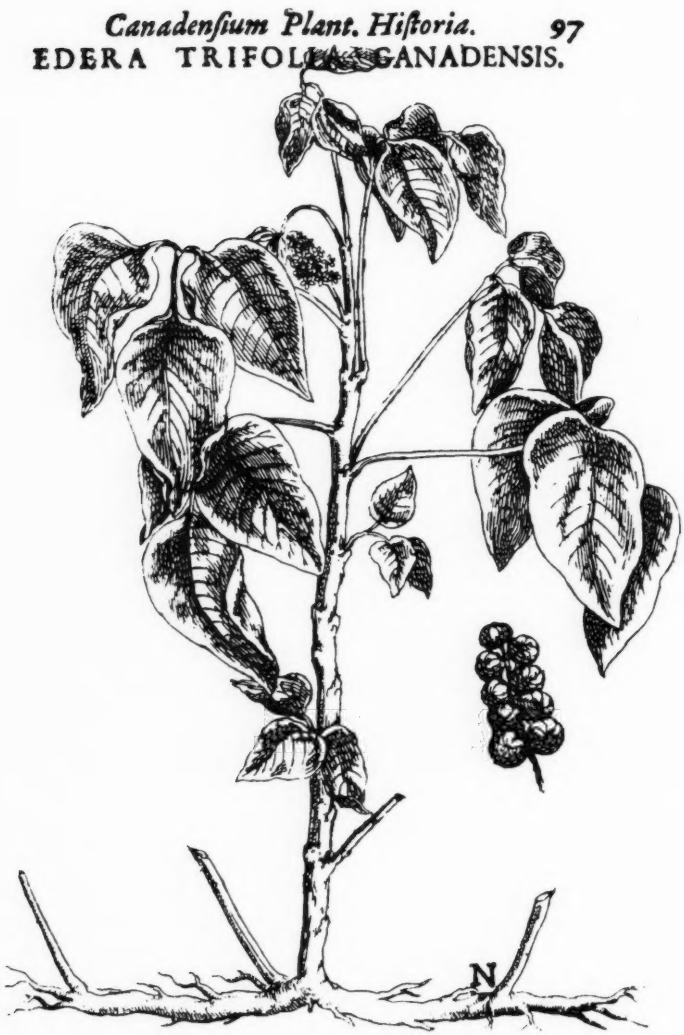


Fig. 18. Edera trifolia Canadensis (*Toxicodendron radicans* (L.) Kuntze) from Cornut's *Canadensium Plantarum*. p. 97. 1635. x.85 of the original.

discover these 'signatures'. The latter, whose inception is accredited to Paracelsus, was developed into its highest form by Giambattista Porta, who made only passing mention of *Rhus*,[17] namely, "Rhois fructus rubescit, ubi maturuerit nigrescit, tunc eius decoctum capillos denigrat," but we quote a very interesting reference, admittedly written in the light of the doctrine of signatures, by the London 'herberist,' William Coles[18]:

Of Sumack.

The Names.

IT is called in Greek ῥόος & ῥοῦς, from the red, or Scarlet colour of the ſeed, which is therefore called ἐρυθρόδανον ſignifying no more but *Red-Pliny* calleth it alſo *Rhus* in Latine, ſaying that it hath not any pure Latine Name, yet *Gaza* tranſlateth it *Fluida*, ſuppoſing it to come from ῥέω *fluo*, for no reaſon at all. Some call it *Rhus* ſimply without any Epithet, as *Matthiolus* &c. Others with one, as *Rhus Coriaria*, becauſe the *Coriers* uſe it about their Leather, and *Rhus Obſoniorum*, becauſe it is uſed about ſauce, the ſhops call it *Sumach*, and ſo do *We* in *Engliſh*.

The Kindes.

To this kind may be referred theſe five ſorts, and not improperly. 1 Coriare Sumack. 2 Virginian Sumack. ..... 4 Venice Sumack. .....

The Forme.

Coriars Sumack groweth in our Gardens to be two or three yards high, ſpreading ſundry branches with larg winged Leaves, that is, having many ſet on both ſides of a middle rib, ſomewhat like unto Elder, which are ſoft and hairy, with a red ſinew running through the middle of every of them; at the ends of the branches come forth large ſpiked cluſters of whitiſh Flowers, which afterwards become reddiſh, round, and flat ſeed like unto Lentils, with an outward ſkinny huſk. The Root is hard and woody, not growing very deep nor much ſpreading; the Wood is whitiſh, but dyeth black.

The Places and Time.

The firſt groweth in *Syria*, *Pontus*, *Italy*, and *Spain*, where for its profit, it is carefully manured: the place of the ſecond may be known by its name: the third groweth about *Mompelier*, and divers other places: the fourth in *Savoy*, and on the *Apenine* Hils, the laſt by old *Windſor Park-Corner*, in *Suſſex*, *Hartford-ſhire*, and *Kent*, as well as beyond the Sea. They flower for the moſt part in *July*, and their ſeed is ripe in *Autumne*.

The Temperature.

Both the Leaves, fruit and ſeed of Sumack, are cold in the ſecond, and dry in the third degree, being alſo of a very binding quality.

The Signature and Vertues.

The Reddiſh colour of the ſeeds of Sumack, did teach thoſe that found out the Vertues of Plants by their Signatures, that it is good for the bloody flix, which is a diſtemper of the Belly with exulceration and excoriation, ſo that blood is voided, whereunto great paines with gripings are joyned; and upon this account it is preſcribed generally by all thoſe that meddle with the cures of diſeaſes, as alſo for ſtopping all other Fluxes of the Belly, the inordinate Courſes of Women, the Whites alſo, and all other immoderate Iſſues of blood whatſoever: the Leaves being either boyled in Wine, and drunk, or the ſeed eaten in Sawces with Meat, or the decoction ſet in ſome convenient place, as the Caſe of a Cloſe Stool, whence the fume may powerfully aſcend into the bodies of thoſe, that are thus diſeaſed; and the ſaid decoction maketh the Hair black, that is waſhed therewith: The leaves and ſeeds may be uſed ſeverall other ways for the ſaid Fluxes, as in Broths, Baths, Gliſters, &c. The ſaid decoction of the Leaves and Seed in Wine, doth alſo cloſe up the Stomacks of thoſe that are much given to vomiting, and being mixed with vinegar and a little honey, it is good againſt *Gangrenes* and *Cankers*. The juyce that is gotten out of the dryed Leaves by boyling them in water, being kept boyling till it have the conſiſtence

of Honey, helpeth the roughneſſe of the tongue and throat, and performeth all thoſe effects, for which, *Lycium* is commended; The ſeed is likewiſe boyled in Water, and the decoction thereof evapored to the thickneſſe of honey, as the former, is more effectuall then the ſeed it ſelfe; The juyce of the green Leaves dropped into the eares, dryeth up the moiſture, and running of them; The ſeed beaten, and boyled into a Pultis, and applyed to any inflammation, or hot Impoſthume, cooleth them much, and doth alſo take away the pain, and black and blew marks, that come of bruiſes and blowes, as alſo the frettings and gallings of the skin; the ſame alſo, applyed with the fine powder of Oaken Coales, helpeth the *Hemeroids* or *Piles*, when they bleed too much; It is ſingular good alſo to be applyed to Ruptures, both inwardly and outwardly, and to ſtay defluxions of hot and ſharp Rhewmes into the eyes, and againſt other diſtillations of the head and want of ſleep. The decoction of the ſeed is good to waſh the mouth, both to faſten looſe teeth, and to heal putrid and rotten Gums, and the Gum that ſometimes iſſueth out of the tree, is good for the ach of hollow teeth, being put thereinto. The ſaid Leaves are ſo aſtringent that they may be ſubſtituted inſtead of *Acacia*. Though the *Virginian Sumack*, be kept only as a rarity or ornament to a Garden or Orchard, yet it is conceived that if tryall were made it might work ſome of the foreſaid effects. The leaves of *Coggygria* or Venice Sumack, are ſold in the Markets of *Spain* and *Italy*, for great ſums of Money unto thoſe that dreſſe Spaniſh *Leather*, for which purpoſe they are very excellent, as thoſe of the *Cortars* Sumack alſo are; the Woods, eſpecially of the Roots of every of them are a Commodity that Dyers make much uſe, ſome of them dying black, ſome yellow, and ſome red. The Gall is by the bitterneſſe and harſhneſſe, found to be both drying, and diſcuſſing, and is very effectuall to kill Wormes in the Belly or Stomack; but it worketh much upon the brain, cauſing evill accidents thereunto. It keepeth Mothes from Garments and woollen Cloathes, giving unto them a good ſcent, and therefore it is much uſed to be laid in Wardrobes, Cheſts, Preſſes, and the like. The .... Venice, are almoſt as effectuall as the firſt, and may be uſed for the purpoſes aforeſaid, but then the quantity muſt be augmented, for they are weaker.

In 1696 Leonard Plukenet,[19] in *Almagestum Botanicum*, the fourth part of his *Opera Omnia Botanica*, lists eleven plants as species of *Rhus*, the last four of which apparently are the first references to the African species. These are illustrated in plate 219 (see Fig. 19) in his *Phytographia*. Besides *Rhus Coriaria* and the African species three American species occur, *Rhus typhina*, *Rhus glabra* and *Rhus Copallina*, the last of which appears here without question as *Rhus Obsoniorum similis Americana, Gummi candidum sundens non serrata, foliorum rachi medio alata.*

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17 Page 132 of the *Phytognomica*.

18 Chapter CCLVII of Coles' *Adam in Eden* as it applies to *Rhus*. In the index, or "A Table," *Rhus* is referred to as "Sumack of divers sorts, 257," however the account quoted is from pages 13-15 following p. 396 in the Missouri Botanical Garden Library copy! (The reproduction is reduced one-half from the original.)

19 Or Pluc'net.

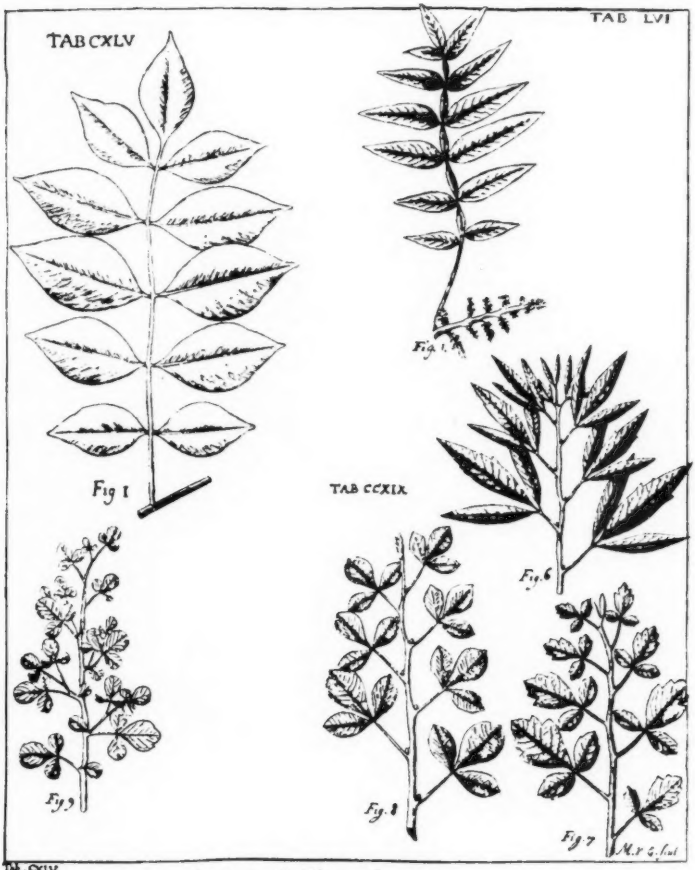

Fig. 19. This is a composite plate of Pluc'net's classical illustrations from the *Phytographia* of the *Opera omnia botanica*. 1691-2. Fig. 1 is Arbor Americana alatis folijs fusco lacteo Venenata (forte) Ahoay-miri, (*Toxicodendron Vernix* (L.) Kuntze) from plate 45. Fig. J is Rhoe Obsoniorum similis, Americana Gummi candidum sun-

dens, non serrata, foliorum rachi medio alata (*R. Copallina* L.) from plate 56. Figs. 6-9 are Rhus Africanum trifoliatum majus folijs subtus argenteis, acutis, & margine incisis (*R. angustifolia* L.), Rhus Afric. trifoliatum majus, folijs obtusis, & incisis, hirsutie pubescentibus (*R. laevigata* L.), Rhus Afr. trifoliat. majus folij subrotundo integro, molli & incano (*R. laevigata* L.), and Rhus Afric. trifoliat. minus glabrum, splendenti folio subrotundo integro, forte Lentiscus Africana triphyllos quorundam (*R. lucida* L.), respectively, from plate 219. x .65 of the originals (retouched).

Fig. 20. Terebinthus maxima pinnis paucioribus atq. rotundioribus fructu racemoso sparso (*Metopium Brownei* (Jacq.) Urb.), from volume 2 of Sloane's *Natural History of Jamaica*. Plate 199, fig. 3. 1725. x .4 of the original.

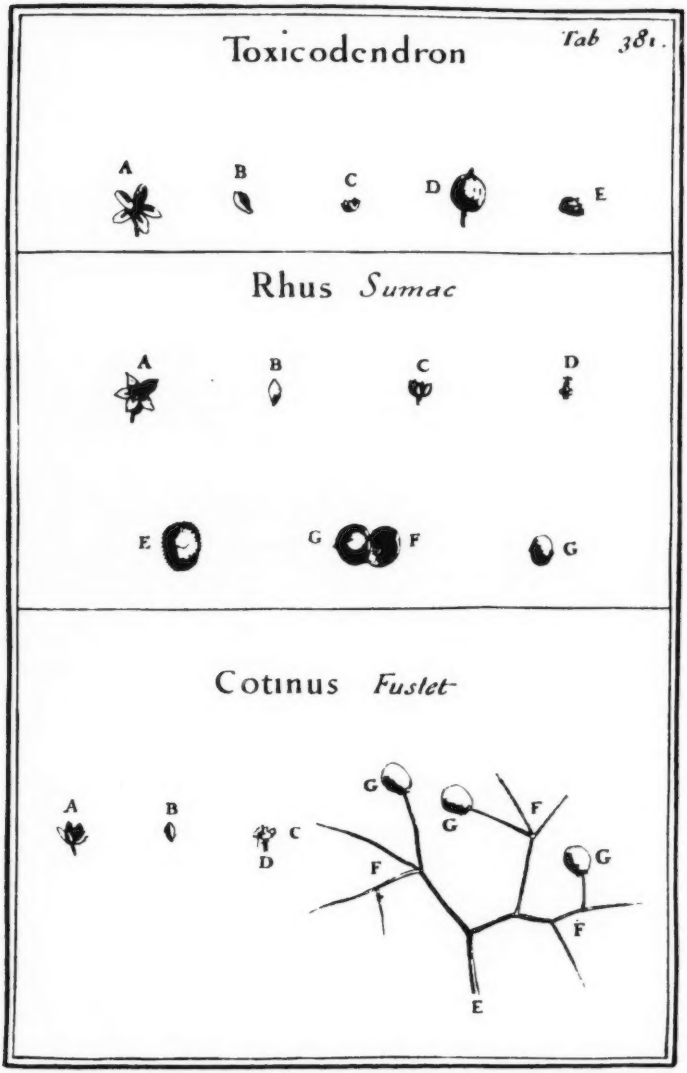

Fig. 21. This is a composite plate of *Rhus* and *Toxicodendron* from plate 381 and of *Cotinus* from plate 380 from Tournefort's *Institutiones rei herbariae*. 1700. The illustrations of *Cotinus* replace the illustrations of *Tilia* in plate 381 in the original.

Metopium Brownei (Jacq.) Urb. first appears with description and illustration (Fig. 20) as *Terebinthus maxima, pinnis paucioribus majoribus atque rotundioribus, fructu racemoso sparso* or the Hog Doctor-tree or Boar-tree, in 1696 in Sloane's *Catalogus Plantarum, quae in Insula Jamaica, Spont proveniunt.*

Fig. 22. Sits s. Sits-dsju, Urus no Ki (*Toxicodendron vernicifera* (DC.) Barkl. & Barkl.), icones 792 from Kaempfer's *Amoenitatum exoticarum.* 1712. x .6 of the original.

The Asiatic sumacs, *Toxicodendron vernicifera* (DC.) Barkl. & Barkl. and *T. succedanea* (L.) Kuntze, enter botanical literature with illustrations (Figs. 22 and 23) first in 1712 in Engelbert Kaempfer's *Amoenitatum Exoticarum* as *Sitz; Sitz dsju; Sitz planta vulgo Urus seu Urus no ki;* or *Arbor Juglandis, fructu racemoso cicerio facie,* and as *Fari no ki;* or *Arbor vernicifera spuria, sylvestris, angustifolia,* respectively.

SECTIO I.

De Arboribus, & Fruticibus flore roſaceo, cujus piſtillum abit in fructum unicapſularem.

GENUS I.

Cotinus. *Fuſſet.*

Tab. 320. COTINUS eſt plantæ genus, flore A roſaceo, plurimis ſcilicet petalis B in orbem poſitis conſtante: ex cujus calyce D ſurgit piſtillum C quod deinde abit in fructum G an unicapſularem? in his enim regionibus ad maturitatem non pervenit: innaſcitur autem ramulis E in capillamenta F villoſa deſinentibus.

Cotini ſpeciem unicam novi.

Cotinus cotaria Dod. Pempt. 780. *Coccigrya ſive Cotinus putata J. B. 1. 494.*

GENUS II.

Toxicodendron.

Tab. 321. TOXICODENDRON eſt plantæ genus, flore A roſaceo, plurimis ſcilicet petalis B in orbem poſitis conſtante, ex cujus calyce C ſurgit piſtillum quod deinde abit in fructum D ſubrotundum, ſiccum, plerumque ſtriatum, ſemine fœtum E.

Toxicodendri ſpecies ſunt.

Toxicodendron triphyllon, glabrum. *Edera trifolia, Canadenſis Corn. 96.*

Toxicodendron triphyllon, folio ſinuato, pubeſcente. *Hedera trifoliæ Canadenſi affinis planta: Arbor venenata quorundam H. R. Par.*

Toxicodendron à vocibus Græcis τοξικὸν *Venenum,* & δένδρον *Arbor.* Dionyſius enim Joncquetus, Doctor Medicus Pariſienſis & in Horto Regio doctiſſimus Botanices Profeſſor arborem venenatam appellare ſolebat alteram ſpeciem de qua locuti ſumus.

GENUS III.

Rhus. *Sumac.*

RHUS eſt plantæ genus, flore A roſaceo, plurimis ſcilicet petalis B in orbem poſitis conſtante, ex cujus calyce C ſurgit piſtillum D quod deinde abit in capſulam E ſubrotundam, quaſi reniformem, ſemine fœtam F ejuſdem formæ G. Tab. 321.

Rhois ſpecies ſunt.

Rhus folio Ulmi C. B. Pin. 414. *Rhus ſive Sumach J. B. 1. 555. Rhus coriaria Dod. Pempt. 779.*

Rhus Virginianum C. B. Pin. App. 517.

Rhus Canadenſe, folio longiori, utrinque glabro.

In 1700, Tournefort, in *Institutiones Rei Herbariae*,[20] disregarding the African species and *Metopium*, divided the then known species of *Rhus*, with his characteristically excellent feeling for generic concepts, into three clearcut genera, each of which he illustrates (Fig. 21) and describes as quoted on the preceding page.

20 "Classis XXI de Arboribus et Fruticibus, Flore Rosaceo. Section I. De Arboribus, and Fruiticibus, flore rosaceo, cujus pistillum abit in fructum unicapsularem." (The reproduction is reduced 25 per-cent from the original).

Fig. 23. Fasi no Ki (*Toxicodendron succedanea* (L.) Kuntze), icones 795 from Kaempfer's *Amoenitatum exoticarum*. 1712. x .6 of the original.

Fig. 24. Rhus Virgin. panicula sparsa ramis patulis glabris (*R. glabra* L.), from Dillenius' *Horti elthamensis*. p. 322. 1732. x .4 of the original.

Fig. 25. Toxicodendron rectum foliis minoribus glabris (*Toxicodendron radicans* (L.) Kuntze) from Dillenius' *Horti elthamensis*. p. 388. 1732. x.5 of the original.

Herman Boerhaave in 1727 follows Tournefort in distributing the species in the three genera, *Cotinus, Toxicodendron* and *Rhus*. With *Rhus Coriaria* and the American pinnate leaved members, he includes the African species in this narrowed concept of *Rhus*.

Early in the eighteenth century botanical illustrations definitely took a turn for the better, illustrative of this may be cited the illustrations of *Rhus* in the works of Dillenius (Figs. 24, 25 and 26) and Burman (Fig. 27).

In 1749, Linnaeus lists for medical use in his Materia Medica (pages 49-50), the three following species:

150. **RHUS** foliis pinnatis ſerratis (ſubtus villoſis).
Hort. cliff. 110. *Upſ* 68.
RHUS folio ulmi. *Bauh. pin.* 414.
LOC: Gallia, Italia.
PHARM: SUMACH Flores, Semina.
QUAL: ſubvenenata, auſtera. *Rarior, cauta.*
VIS: adſtringens, refrigerans.
USUS: diarrhœa, Dyſenteria, Scelotyrbe, Rhagas.
COMP:

151. **RHUS** foliis pinnatis integerrimis (petiolo integro). *Hort. cliff.* 110. *Hort. Upſ.* 68.
SITZ vel Sitz-diu. *Kæmpf. amœn.* 791. *t.* 792.
LOC: Japoniæ, Virginiæ paludoſa. *Arbor manſueta.*
PHARM: VERNICIS Reſina.
QUAL: venenata. *Externa.*
VIS
USUS: Hæmorrhois.
COMP: *Ungv.* martiatum.

152. **RHUS** foliis pinnatis, petiolo membranaceo articulato. *Roy. lugdb.* 244.
RHOI obſoniorum ſimilis americana non ſerrata, rachi media alata. *Pluk. phyt.* 56. *f.* 1.
LOC: Virginia. *Arbor manſucta.*
PHARM: COPAL Reſina.
QUAL: *Exoleta*
VIS:
USUS:
COMP:

(x .85).

Fig. 26. Toxicodendron foliis alatis fructu rhomboide (*Toxicodendron Vernix* (L.) Kuntz) from Dillenius' *Horti eltbamensis*. p. 391. 1732. x.5 of the original.

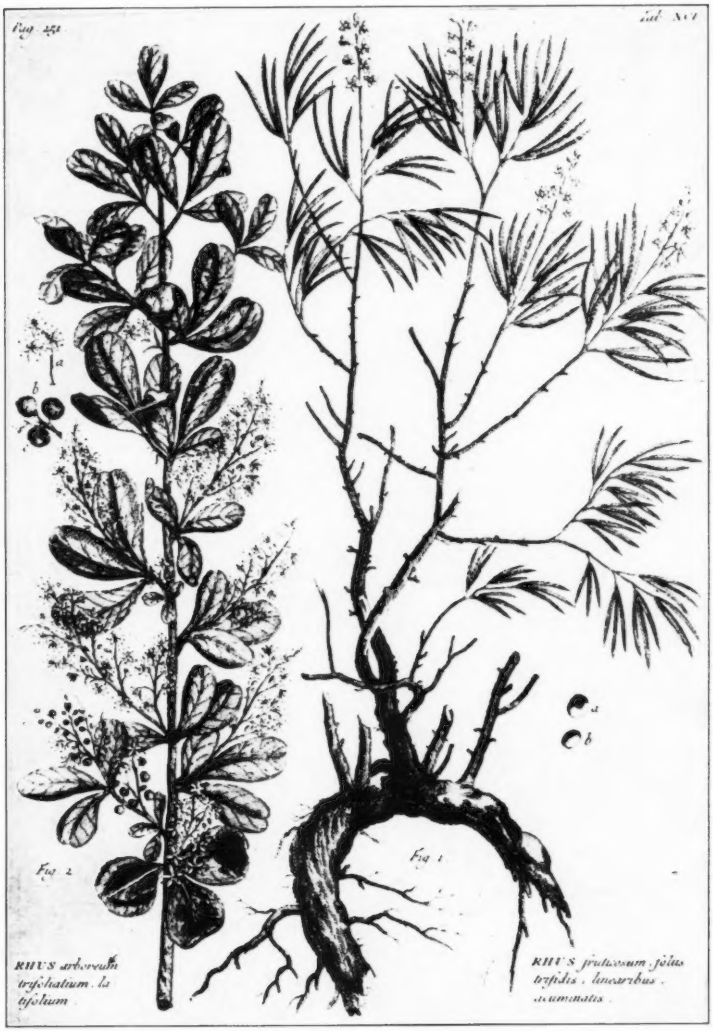

Fig. 27. Plate 91, illustrating Rhus arboreum trifoliatum latifolium (*R. lucida* L.) and Rhus fruticosum foliis trifidis, linearibus acuminatis (*R. rosmarinifolia* Vahl.) from Burman's Rariorum Africanarum Plantarum. p. 251. 1738-9. x.7 of the original.

In the first editions of the Gardener's Dictionary, Philip Miller, in his interesting treatment of the group, follows Tournefort in placing the members in *Cotinus*, *Toxicodendron*, and *Rhus*. In the seventh edition of 1759, however, he merges *Cotinus* in *Rhus*, as he again does in his eighth edition. Miller's generic treatments from edition six of the *Gardener's Dictionary* follow:

COTINUS, Venice Sumach.

The *Characters* are;

It hath round Leaves, with long Foot-ſtalks: the Flowers are ſmall, conſiſting of five Leaves, which expand in form of a Roſe: are diſpoſed in capillary Branches of very ſlender and ſtiff Filaments or Hairs, which are widely diffuſed after the manner of Plumes, and ſpring out of the top Branches: in the Centre of the Flower is ſituated the Pointal, attended by five minute Stamina: *the Pointal afterward turns to an oval Berry, incloſing one triangular Seed.*

RHUS [ῥόος, takes its Name of ῥέω, to flow; becauſe it ſtops dyſenterial Fluxes of the Belly, and Womens Courſes], The Sumach-tree.

The *Characters* are;

The Flowers conſiſt of five Leaves, which are placed in a circular Order, and expand in form of a Roſe; from whoſe Flower-cup riſes the Pointal, which afterward becomes a roundiſh or almoſt kidney-ſhap'd Veſſel, containing one Seed of the ſame Shape: to which Marks may be added, The Flowers growing in Bunches, and the Leaves are either winged, or have three Lobes.

TOXICODENDRON, [of τοξικὸν, Poiſon, and δένδρον, a Tree] Poiſon-tree, *vulgo.*

The *Characters* are;

The Flower conſiſts of five Leaves, which are placed orbicularly, and expand in form of a Roſe; out of whoſe Flower-cup riſes the Pointal, which afterward becomes a round-ſh, dry, and, for the moſt part, furrowed Fruit, in which is contained one compreſs'd Seed.

(x .8).

In Linnaeus' *Species Plantarum* of 1753, from whence official nomenclature for seed plants now begins, *Cotinus* and *Toxicodenron* are submerged in the inclusive genus *Rhus*. In this work binomial terminology is consistently used. Linnaeus' treatment of *Rhus* in edition one (pages 265-267) of *Species Plantarum* follows [21]:

TRIGYNIA.

RHUS.

1. RHUS foliis pinnatis obtuſiuſcule ſerratis ovalibus ſubtus villoſis. *Mat. med.* 150. *Coriaria.*
   Rhus foliis pinnatis ſerratis. *Hort. cliff.* 110. *Hort. upſ.* 68. *Roy. lugdb.* 243. *Sauv. monſp.* 227.
   Rhus folio ulmi. *Bauh. pin.* 414.
   Rhus coriaria. *Dod. pempt.* 779.
   Habitat in Europa *auſtrali.* ♄

2. RHUS foliis pinnatis ovatis acuminatis ſerratis, ſubtus tomentoſis. *javanica.*
   Habitat in Java. *Osbeck.*

3. RHUS foliis pinnatis ſerratis lanceolatis utrinque nudis. *glabra.*
   Rhus foliis pinnatis ſerratis. *Gron. virg.* 148. *Cold. noveb.* 63.
   Rhus virginicum, panicula ſparſa, ramis patulis glabris. *Dill. elth.* 323. *t.* 243. *f.* 314.
   Rhus anguſtifolium. *Bauh. pin.* 414.
   Sumach anguſtifolium. *Bauh. prodr.* 158. *Burſ. XXII.* 77.
   Habitat in America *ſeptentrionali.*

4. RHUS foliis pinnatis integerrimis, petiolo integro. *Mat. Venin. med.* 151.
   Rhus foliis pinnatis integerrimis. *Hort. cliff.* 110. *Hort. upſ.* 68. *Gron. virg.* 148. *Roy. lugdb.* 244. *Cold. noveb.* 64.
   Toxicodendron foliis alatis, fructu rhomboide. *Dill. elth.* 390. *t.* 292. *f.* 377.
   Arbor americana, alatis foliis, ſucco lacteo venenata. *Pluk. alm.* 45. *t.* 145. *f.* 1.

21 Number 9, *R. Cobbe* has proved not to be a *Rhus* and has therefore been deleted from the quotation.

Arbor Poyſon-wood-Tree. *Aſt. angl. n.* 367. *p.* 145.
Sitz ſ. Sitz-dliu. *Kæmpf. amœn.* 791. *t.* 792.
Habitat in America *ſeptentrionali*, Iaponia. ♄

Copallinum. 5. RHUS foliis pinnatis integerrimis, petiolo membranaceo articulato. *Roy. lugdb.* 24. *Mat. med.* 152.
Rhus elatior, foliis impari pinnatis, petiolis membranaceis articulatis. *Gron. virg.* 149.
Rhus obſeniorum ſimilis americana, gummi candidum fundens non ſerrata, foliorum rachi medio alata. *Pluk. alm.* 318. *t.* 56. *f.* 1.
Habitat in America *ſeptentrionali*. ♄

radicans. 6. RHUS foliis ternatis: foliolis petiolatis ovatis nudis integerrimis, caule radicante. *Hort. cliff.* 110. *Gron. virg.* 133. *Roy. lugdb.* 244.
Hedera trifolia canadenſis. *Corn. canad.* 96. *t.* 97. *Barr. ic.* 228.
β. Toxicodend. on amplexicaule, foliis minoribus glabris. *Dill. eltb.* 390.
γ. Toxicodendron rectum, foliis minoribus glabris. *Dill. eltb.* 389. *t.* 291. *f.* 375.
Habitat in Virginia, Canada. ♄

Toxicodend. 7. RHUS foliis ternatis: foliolis petiolatis angulatis pubeſcentibus.
Rhus foliis ternatis: foliolis petiolatis ovatis acutis pubeſcentibus: nunc integris, nunc ſinuatis. *Gron. virg.* 149.
Toxicodendron triphyllum, folio ſinuato pubeſcente. *Tournef. inſt.* 611.
Arbor trifolia venenata virginiana, folio hirſuto. *Raj. hiſt.* 1799.
Habitat in Virginia, Canada. ♄

tomentoſum. 8. RHUS foliis ternatis: foliolis ſubpetiolatis rhombeis angulatis ſubtus tomentoſis.
Rhus foliis ternatis: foliolis ovatis utrinque acutis dentatis: lateralibus petiolatis. *Hort. cliff.* 111.
Rhus foliis ternatis: foliolis petiolatis ovatis acutis dentatis. *Vir. cliff.* 25. *Roy. lugdb.* 244.
Rhus africanum trifoliatum majus, foliis obtuſis & inciſis hirſutis pubeſcentibus. *Pluk. alm.* 319. *t.* 219. *f.* 7.
Vitex trifolia minor indica ſerrata. *Comm. hort.* 1. *p.* 179. *t.* 92.
Habitat ad Cap. b. Spei. ♄

10. RHUS foliis ternatis: foliolis petiolatis lineari-lanceolatis integerrimis ſubtus tomentoſis. *Hort. cliff.* 111. *Roy. lugdb.* 244. *angustifolium.*
Rhus africanum trifoliatum majus, foliis ſubtus argenteis acutis & margine inciſis. *Pluk. alm.* 319. *t.* 219. *f.* 6.
Rhus fruticoſum, foliis trifidis linearibus acuminatis. *Burm. afric.* 251. *t.* 91. *f.* 1.
Habitat in Æthiopia. ♄

11. RHUS foliis ternatis: foliolis ſeſſilibus cuneiformibus lævibus. *Vir. cliff.* 25. *Hort. cliff.* 111. *Hort. upſ.* 68. *Roy. lugdb.* 243. *lucidum.*
Rhus africanum trifoliatum minus glabrum, ſplendente folio ſubrotundo integro. *Pluk. alm.* 319. *t.* 219. *f.* 9.
Rhus arboreum trifoliatum latifolium. *Burm. afr.* 252. *t.* 91. *f.* 2.
Vitex trifolia minor indica rotundifolia. *Comm. hort.* 2. *p.* 181. *f.* 93.
Habitat ad Cap. b. Spei. ♄

12. RHUS foliis ſimplicibus obovatis. *Cotinus.*
Cotinus foliis obverſe ovatis. *Hort. cliff.* 111. *Roy. lugdb.* 243.
Cotinus coriaria. *Dod. pempt.* 780.
Cocconilea ſ. Coccygria. *Bauh. pin.* 415.
Habitat in Lombardia Italiæ & *ad radices* Apenninorum. ♄

(x .8).

Linnaeus' characterization of his inclusive genus *Rhus*, as given in the *Genera Plantarum* of 1754 (page 129), is:

331. RHUS.* *Tournef.* 381. Toxicodendron *Tournef.* 381. Cotinus *Tournef.* 320.

CAL. *Perianthium* quinquepartitum, erectum, perſiſtens.
COR. *Petala* quinque, ovata, erecto-patentia.
STAM. *Filamenta* quinque, breviſſima. *Antherae* parvæ, corollà breviores.
PIST. *Germen* ſubrotundum, magnitudine corollæ. *Styli* vix ulli. *Stigmata* tria, corcata, parva.
PER. *Bacca* ſubrotunda, unilocularis.
SEM. unicum, ſubrotundum, oſſeum.
OBS. Rhus T. *Bacca trilocularis: nucleo globoſo.*
Toxicodendron. *Bacca glabra, ſtriata: nucleo compreſſo ſulcato.*
Vernix *fructificatione dioica.*

(x .8).

Binomials had been much used previous to the publication of Linnaeus' *Species Plantarum* in 1753, as in Bauhin's *Pinax*, but apparently they had never been used consistently before. Their use became, however, quite widespread immediately after Linnaeus' use of them, probably due in part to Linnaeus' wide following and in part because of their greater convenience.[22] The transition from polynomial to binomial terminology after 1753 was not as abrupt as might seem at first and as is usually assumed, for polynomials did not immediately disappear. Miller ingeniously makes the transitions from the consistant use of polynomials in the first seven editions of his *Gardener's Dictionary*, to the use of binomials in his eighth edition, by the mere parenthetic insertion of the specific epithet after the generic name in the polynomial epithet he had used in the seventh edition. Characteristic examples of the treatment of *Rhus* species in this transitional period between the general use of polynomials and the exclusive use of binomials, are those for *Rhus Coriaria* L. by Philip Miller in the eighth edition of the *Gardener's Dictionary* and by Willdenow in his 1798 edition of Linnaeus' *Species Plantarum*, respectively:

22 It might be well to remark here that the use of binomials in the latter part of the eighteenth century was quite a matter of individual choice, for at that time there was no concerted opinion for their employment except that of increasing usage. However, by the First International Botanical Congress in Paris in 1867, the use of binomials was taken for granted. Until the first Botanical Congress— when it was offiicially agreed to accept Linnaeus' *Species Plantarum* of 1753 as a convenient but definite starting point for the nomenclature of seed plants and to employ the first binomial published by Linnaeus in the *Species Plantarum* of 1753 or when not published there the first applicable name published thereafter—individual choice of nomenclature for a plant could be exercised in the selection of any of the names previously used, or even new ones invented, or if priority was exercised at all (and it usually was as good usage began to require it), it was absolute in that it went back to the first applicable binomial of any period. Where new species were published, and often following the republication of an old species, a short Latin description of the species usually followed the binomial. To all intents and purposes this was a polynomial, and was cited under synonymy by botanists as such, along with pre-Linnaean polynomials, so that a series of synonymous polynomials were often given under the binomial term used by Linnaeus' contemporaries, much as a Latin diagnosis is now given. The official agreement for the starting point in nomenclature was not a universal agreement by any means, for many years later we find certain botanists grudgingly using this artificially selected point of nomenclatorial departure, if using it at all.

1. RHUS (*Coriaria*) foliis pinnatis obtuſiuſculè ſerratis, ovalibus ſubtus villoſis. Lin. Sp. Plant. 379. *Sumach with winged leaves which are obtuſely ſawed, oval, and hairy on their under ſide.* Rhus folio ulmi. C. B. P. 414. *Elm-leaved Sumach.*

1. RHUS *Coriaria.*

R. foliis pinnatis, foliolis ellipticis obtuſe dentatis, ſubtus villoſis. *Willd. arb. p.* 287. *

R. foliis pinnatis obtuſiuſculis ſerratis ovalibus ſubtus villoſis. *Mat. med.* 87. *Mill. dict. n.* 1. *Kniph. cent.* 5. *n.* 74. *Blackw. t.* 486. *Ludw. ect. t.* 122. *Roth. germ. II.* 367.

R. foliis pinnatis ſerratis. *Hort. cliff.* 110. *Hort. upſ.* 68. *Roy. lugdb.* 243. *Sauv. monſp.* 227. *Gron. orient.* 91.

R. (*Coriaria*) folia pinnata; petiolus inter foliola ultima ſubalatus; foliola ovalia obtuſiuſcula ſerrata, ſupra ſcabra, ſubtus villoſa. *Ehrh. Beitr.* 6. *p.* 88.

R. folio ulmi. *Bauh. pin.* 414.

R. coriaria. *Dod. pempt.* 779.

Houttuyn Lin. Pſl. Syſt. 6. *p.* 340.

Gerber Sumach. W.

Habitat in Europa *auſtrali*, Syria, Palaeſtina. ♄ (v. v.)

Besides the marked change in method of taxonomic treatment during this transitional period, new species were being added to those known. In 1759, in the tenth edition of *Systema Naturae,* Linnaeus added two[23] new species of *Rhus* to the eleven treated in the *Species Plantarum.* There were *Rhus typhina* and *Rhus Metopium.* By the publication of Willdenow's (the fourth) edition of *Linnaeus' Species Plantarum* of 1798, twenty-three species of the *Rhus-complex* (as now delimited) were included.

But the matter of generic segregation was not settled by Linnaeus' works, for in 1768, in his eighth edition of the *Gardener's Dictionary,* Philip Miller continues his segregation of *Toxicodendron* in stated opposition to Linnaeus. Miller's characterization of *Rhus* and *Toxicodendron* from his eighth edition follows:

23 A third species, *R. Cominea* has proved not to be *Rhus.*

RHUS. Tourn. Inſt. R. H. 611. tab. 381. Lin. Gen. Plant. 331. [ῥύς takes its name from ῥέω to flow, becauſe it ſtops dyſenterial fluxes of the bowels.] Sumach.

The CHARACTERS are,

The empalement of the flower is permanent, erect, and cut into five parts. The flower has five oval, erect, ſpreading petals, and five ſhort ſtamina terminated by ſmall ſummits, ſhorter than the petals; it has a roundiſh germen as large as the petals, with ſcarce any ſtyle, crowned by three ſmall ſtigmas. The germen afterward becomes a roundiſh hairy berry, incloſing a ſingle hard ſeed of the ſame form.

This genus of plants is ranged in the third ſection of Linnæus's fifth claſs, which includes thoſe plants whoſe flowers have five ſtamina and three ſtyles.

TOXICODENDRON. Tourn. Inſt. R. H. 610. tab. 381. Rhus. Lin. Gen. Plant. 331. [τοξικόν, poiſon, and δένδρον, a tree.] Poiſon-tree, vulgò.

The CHARACTERS are,

The male flowers are upon different plants from the female; they have a ſmall empalement cut into five points at the brim, and five ſmall roundiſh petals which ſpread open; they have five ſhort ſtamina, terminated by roundiſh ſummits. The female flowers have empalements and petals like the male; they have no ſtamina, but in the center is ſituated a roundiſh germen, ſupporting three ſmall ſtyles, crowned with globular ſtigmas. The germen afterward turns to a berry with one or two cells, incloſing one ſeed in each.

This genus of plants is ranged in the third ſection of Linnæus's fifth claſs, which includes the plants whoſe flowers have five ſtamina and three ſtyles, and has joined them to his genus of Rhus; but this genus ſhould be ranged in the fifth ſection of his twenty-ſecond claſs, which contains thoſe plants whoſe flowers are male and female on different plants, and the male flowers have five ſtamina.

Such was the general situation concerning the treatment of the *Rhus-complex,* except for the addition of a few species, when A. P. de Candolle reworked the group in 1825 in his *Prodramus,* the first comprehensive, post-Linnaean treatment of this group.

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Summary

Rhus Coriaria L. and *Cotinus Coggygria* Scop. have been known and used considerably since Greek times. The American members of the genus began to be mentioned at the beginning of the seventeenth century. By the last of the seventeenth century the African species were being described. The Asiatic species were making their appearance in botanical literature very early in the eighteenth century. While Linnaeus in his *Species Plantarum* lists but eleven (thirteen in edition ten of *Systema Naturae*) plants that undoubtedly belong to the *Rhus* complex, as judged by modern works, twenty-eight species of approximately one hundred and twenty-five now known, were known to Linnaeus and his contemporaries.

A tabular summary of the species known to Linnaeus and his contemporaries, with their synoymy as well as could be determined, is printed as an appendix to this article.[24]

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24 The names given in bold face are those acceptable in the more conservative treatments of the *Rhus* complex. Engler's delimitation of species in his monographic treatment of the ANACARDIACEAE in DeCandolle's *Monographiae Phanerogamarum* **4**, 1883, is followed except for the delimitation of the South African and American species where Schonland's *The South African Species of Rhus L.* in *Bothalia* **3**, pt. 1, 1930, and Barkley's *A Monographic Study of Rhus and Its Immediate Allies in North and Central America, Including the West Indies* in the *Annals of the Missouri Botanical Garden* **24**, pt. 3, 1937, are followed. Because of the obvious difficulties involved, categories below that of species have been ignored in this treatment.

Summary of PreLinnaean Synonymy in Rhus

RHUS CORIARIA L. Sp. Pl., ed. 1, 1: 265. 1753. Common sumach. Elm-leav'd sumach.*

Coriaria obsoniorum. *Ray*, Hist. Pl., 3**:56. 1704.***

Coriare Sumack. *Coles*, Adam in Eden, chapter 257. 1657.

Coriars Sumack. *Gerarde*, Herball, p. 1291. 1597.

de Rhoë sive Rhucoriaria. *Dodon.*, Stirp. Hist. Pemp. Sex, p. 766. 1583.

Gerberbaum. *Durante*, Hort. Sanit., p. 847. 1609. Matth., Kräuterbuch, p. 67. 1634. *Zvinger.*, Kräuter-Buch, p. 146. 1694.

Rhois culinarij. *Cordus*, Dispensatorium, (p. 122. 1556,) p. 143. 1575.

Rhus. *Bauhin*, Pinax, p. 414. 1623. *Boerhaave*, Hist. Pl., p. 226. 1727. *Boerhaave*, Index Pl., 2: 381. 1727. *Camerar.*, Deplantis Ep. Util., p. 121. 1584. *Ibn-Tsina (Avicenna)*, Canon Med. Interp., p. 220. 1658. *(Stephanus,)* Nominibus, p. 64. 1547. *Zvinger.*, Kräuter-Buch, p. 146. 1694.

Rhus Coriaria. *Aiton*, Hort. Kew. 1: 365. 1789. *Bauhin*, Pinax, p. 414. 1623. *Boerhaave*, Hist. Pl., p. 226. 1727. *Linnaeus*, Sp. Pl., 1:265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 1, 1807. *Miller*, Gard. Dict., ed. 8, no. 1. 1768. *Ray*, Hist. Pl., p. 1590. 1688. *Willdenow* in Linn. Sp. Pl., ed. 4, 1:1477. 1798.

Rhus (Coriaria) foliis pinnatis obtusiuscule serratis, ovalibus subtus villosis. *Miller*, Gard. Dict., ed. 8, no. 1. 1768.

Rhus (Coriaria) folio pinnata; petiolus inter foliola ultima subalatus; foliola ovalis obtusiuscule serrata, supra scabra subtus villosa. *Willdenow* in Linn. Sp. Pl., ed. 4, 1: 1477. 1798.

Rhus culinarius obsoniorum. *Cordus*, Dispensatorium, in index. 1575.

Rhus culinaria sive obsoniorum. *Boerhaave*. Hist. Pl., p. 226. 1727. *Dodon.*, Stirp. Hist., p. 766. 1583.

Rhvs culinarij. *Cordus*, Dispensatorium, p. 75. 1556.

Rhus culinarium. *Cordus*, Dispensatorium, p. 98. 1575.

Rhus foliis pinnatis, foliolis ellipticis obtuse dentatis, subtus villosus. *Willdenow* in Linn. Sp. Pl., ed. 4., 1: 1477. 1798.

Rhus foliis pinnatis obtusiuscule serratis ovalibus subtus villosis. *Aiton*. Hort. Kew., 1: 365. 1789. *Linnaeus*, Sp. Pl., 1: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 1. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4., 1: 1477. 1798.

Rhus foliis pinnatis obtusiuscule serratis, ovato-lanceolatis subtus villosis. *Miller*, Gard. Dict., ed. 7, no. 1. 1759.

Rhus foliis pinnatis serratis. *Linnaeus*, Sp. Pl., 1: 265. 1753. *Royen*, Flor. Leyd., p. 243. 1740. *Sauvages*, Meth. Fol. p. 227. 1751. *Willdenow* in Linn. Sp. Pl., ed. 4, 1: 1477. 1798.

Rhus foliis pinnatis serratis (subtus villosis). *Linnaeus*, Mat. Med., p. 49. 1749.

Rhus folio pinnata, petiolus inter foliola ultima subalatus; foliola ovalia obtusiuscula serrata, supra scabra subtus villosa. *Willdenow* in Linn. Sp. Pl., ed. 4, 1: 1477. 1798.

Rhus folio Ulmi. *Bauhin*, Pinax, p. 414. 1623. *Boerhaave*, Index Pl., 2: 381. 1727. *Linnaeus*, Mat. Med., p. 49. 1749. *Linnaeus*, Sp. Pl., 1: 265. 1753. *Miller*,

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* Also variously known as: Fluidam. Rosaidicos. Rosbar Sardisticos. Ρὸυς Rhu. Rhus Coriariorum. Rhus Erythros. Rhus Monspessulanan. Rhus sumac. Sumac. Sumach Ruellii. Sumagre. Somacho. Smack. Smacke.

** "Dendrologiae."

*** For more complete bibliographical data refer to the appended BIBLIOGRAPHY, p. 328.

Gard. Dict., ed. 8, no. 1. 1768; ed. 7, no. 1. 1759; ed. 6, no. 1. 1752; ed. 2, no. 2. 1740. Pluc'net., Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **3***:56. 1704. *Royen*, Flor. Leyd., p. 244. 1740. *Sauvages*, Meth. Fol., p. 227. 1751. *S. W. A.*, Schola Botanica, p. 276. 1689. *Tournefort*, Inst. Rei Herb., **1**: 611. 1700. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1477. 1798.

Rhus marinus. *Lonicer.*, Kräuter-Buch, p. 133. 1737. *Parkinson*, Theatr. Bot., p. 1451. 1640.

Rhus obsoniorum. *Caesalpin.*, De Plantis, p. 77. 1583. *Lonicer.*, Kräuter-Buch, p. 133. 1737. *Ray*, Hist. Hist. Pl., p. 1590. 1688. *S. W. A.*, Schola Botanica, p. 276. 1689.

Rhus obsoniorum & Coriariorum. *Boerhaave*, Index Pl., **2**: 381. 1727. *l'Obel*, Icones Stirp., **2**: 98. 1591. *Parkinson*, Theatr. Bot., p. 1449. 1640. *Pluc'net.*, Almagestum, p. 318. 1696.

Rhus orientalis. *Parkinson*, Theatr. Bot., p. 1451. 1640.

Rhus, Rhus veterum; coriaria, obsoniorum, & Sumac. *Bauhin*, Pinax, p. 414. 1623.

Rhus rubra. *Parkinson*, Theatr. Bot., p. 1451. 1640.

Rhus sive Sumach. *Boerhaave*, Index Pl., **2**: 381. 1727. *Pluc'net.*, Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **3***:56. 1704. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus, Sumach. *Durante*, Hort. Sanit., p. 847. 1609.

Rhus Syriacum. *Parkinson*, Theatr. Bot., p. 1451. 1640.

Sumach. *Cordus*, Dispensatorium, pp. 75, 122. 1556. pp. 99, 143. 1575. *Lonicer.*, Kräuter-Buch, p. 133. 1737 *(Schönsperger,)* Gart. der Gesundheit, no. 491. 1487.

Sumach Arabum. *S. W. A.*, Schola Botanica, p. 276. 1689.

Sumacho sive Rhus Obsoniorum & Coriariorum. *Parkinson*, Theatr. Bot., p. 1449. 1640. *Pluc'net.*, Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **3**: 56. 1704.

Tsumakh. *Ibn-Tsina* (Avicenna), Canon Med. Interp., p. 220. 1658.

RHUS GLABRA L. Sp. Pl., ed. 1, 1:265. 1753. Carolina sumach. Scarlet sumac.

Rhus Americanum, panicula sparsa herbacea, ramis patula glabris. *Miller*, Gard. Dict., ed. 6, no. 3. 1752; ed. 2, no. 1. 1740.

Rhus angustifolium. *Bauhin*, Pinax, p. 414. 1623. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl., **1**: 265. 1753. ?*Miller*, Gard. Dict., ed. 8, no. 6. 1768; ed. 7, no. 6. 1752. *Ray*, Hist. Pl., **3***: 56. 1704. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus baccis rubentibus, foliis serratis. *Gronovius*, Flor. Virg., 2: 148. 1743.

Rhus Canadense. *Miller*, Gard. Dict., ed. 8, no. 5. 1768.

Rhus (Canadense) foliis pinnatis, obsolete serratis, lanceolatis, utrinque glabris, panicula composita. *Miller*, Gard. Dict., ed. 8, no. 5. 1768.

Rhus Canadense, folio longiori, utrinque glabra. *Miller*, Gard. Dict., ed. 8, no. 5. 1768; ed. 7, no. 5. 1759; ed. 6, no. 4. 1752. *Pluc'net.*, Amaltheum, p. 183. 1705. *Tournefort*, Inst. Rei Herb., **1**:611. 1700.

Rhus Carolinianum. *Martyn*, Gard. Dict., no. 5. 1807. *Miller*, Gard. Dict., ed. 8, no. 4. 1768.

Rhus (Carolinianum) foliis pinnatis serratis lanceolatis, subtus incisis, panicula compacta. *Miller*, Gard. Dict., ed. 8, no. 4. 1768.

Rhus Carolinianum, panicula speciosa coccinea. *Miller*, Gard. Dict., ed. 8, no. 4. 1768; ed. 7, no. 4. 1759.

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* "Dendrologiae."

Rhus elegans. *Aiton*, Hort. Kew., **1**: 366. 1789. *Martyn*, Gard. Dict., no. 5. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus foliis amplis pinnatis, racemis atro-rubentibus. *Gronovius*, Flor. Virg., **1**:33. 1739.

Rhus foliis pinnatis lanceolatis serratis utrinque nudis, floribus dioicis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus foliis pinnatis lanceolatis serratis utrinque nudis, floribus hermaphroditis. *Aiton*, Hort. Kew., **1**: 365. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus foliis pinnatis, obsolete serratis, lanceolatis, utrinque glabris, panicula composita. *Miller*, Gard. Dict., ed. 8, no. 5. 1768; ed. 7, no. 5. 1759.

Rhus foliis pinnatis serratis. *Colden*, Pl. Cold. Nov. Am., p. 105. 1742. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Hort. Ups., p. 681. 1748. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1478. 1798.

Rhus foliis pinnatis serratis lanceolatis utrinque glabris. *Miller*, Gard. Dict., ed. 8, no. 3. 1768; ed. 7, no. 3. 1759.

Rhus foliis pinnatis serratis lanceolatis utrinque nudis. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1478. 1798.

Rhus glabrum. *Aiton*, Hort. Kew., **1**:365. 1789. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Marshall*, Arbustr. Am., p. 128. 1785. *Martyn*, Gard. Dict., no. 4., 1807. *Miller*, Gard. Dict., ed. 8, no. 3. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus glabrum canadense. *Marshall*, Arbustr. Am., p. 129. 1785.

Rhus glabrum carolinense. *Marshall*, Arbustr. Am., p. 129. 1785.

Rhus (Glabrum) foliis pinnatis serratis lanceolatis utrinque glabris. *Miller*, Gard. Dict., ed. 8, no. 3. 1768.

Rhus glabrum panicula speciosa coccinea. *Aiton*, Hort. Kew., **1**: 366. 1789. *Martyn*, Gard. Dict., no. 5. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus ramis ex stipite pullulantibus glabris. *Banister* (in Ray, Hist. Pl., **2**:) 1927. 1688.

?Rhus staturae minoribus, foliis racemisque minoribus. *Gronovius*, Flor. Virg., **1**: 33. 1739.

Rhus tenuifolia Virginiana humilis. *Miller*, Gard. Dict., ed. 1, no. 5. 1752.

Rhus tenuifolia Virginiana humilis: Rhus, angustifolium. *Miller*, Gard. Dict., ed. 6, no. 5. 1752; ed. 1, no. 2. 1731. *Pluc'net.*, Almagestum, p. 318. 1696.

Rhus tenuifolia Virginiana humilis; Rhus Virginianum ramis ex stipite pullulantibus glabris. *Pluc'net.*, Almagestum, p. 318. 1696.

Rhus Virginianum humile. *Ray*, Hist. Pl., **3***: 56. 1704. *Pluc'net.*, Almagestum, p. 318. 1696.

Rhus Virginianum, ramis ex stipite pullulantibus glabris. *Boerhaave*, Index Pl., **2**: 381. 1727. *Dillenius*, Pl. Rar. Hort. Elth., p. 323. 1732. *Pluc'net.*, Almagestum, p. 318. 1696.

Rhus Virginicum. *Linnaeus*, Hort. Ups., p. 68. 1748.

Rhus virginicum panicula sparsa, ramis patulis glabris. *Dil'enius*, Pl. Rar. Hort. Elth., p. 323. 1732. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Miller*, Gard. Dict., ed. 8, no. 3. 1768; ed. 7, no. 3. 1759.

Sumach angustifolium. *Bauhin*, Prodromus, p. 158. 1620. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl. **1**: 265. 1753. *Pluc'net.*, Almagestum, p. 318. 1696. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

RHUS TYPHINA Torner, Cent. Pl. II, p. 14. 1756; Torner in L., Amoen. Acad. 4: 311. 1760.

Rhus foliis pinnatis argute serratis lanceolatis subtus tomentosis. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

* "Dendrologiae."

Rhus foliis pinnatis, foliolis lanceolatis acuminatis argute, serratis subtus pilosiusculis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

?Rhus foliis pinnatis integerrimis, cordato-oblongis acuminatis, ramis petiolisque villosissimis. *Miller*, Gard. Dict., ed. 7, no. 2. 1759.

Rhus foliis pinnatis lanceolatis argute serratis subtus tomentosis. *Aiton*, Hort. Kew., **1**: 365. 1789. *Miller*, Gard. Dict., ed. 8, no. 2. 1768.

Rhus foliis pinnatis serratis lanceolatis, subtus incanis, panicula compacta. *Miller*, Gard. Dict., ed. 8, no. 4. 1768; ed. 7, no. 4. 1759.

Rhus typhinum. *Aiton*, Hort. Kew., **1**: 365. 1789. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Marshall*, Arbustr. Am., p. 129. 1785. *Martyn*, Gard. Dict., no. 2. 1807. *Miller*, Gard. Dict., ed. 8, no. 2. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus (Typhinum) foliis pinnatis lanceolatis, argute serratis subtus tomentosis. *Miller*, Gard. Dict., ed. 8, no. 2. 1768.

Rhus Virginiana. *Parkinson*, Paradisi in sole, p. 611. 1629.

Rhus Virginiaum. *Bauhin*, Pinax, (appendix,) p. 517. 1623. *Boerhaave*, Index Pl., **2**: 381. 1727. *Miller*, Gard. Dict., ed. 8, no. 2. 1768; ed. 7, no. 2. 1759; ed. 6, no. 2. 1752; ed. 1, no. 1. 1731. *Pluc'net.*, Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **3***: 56. 1704. *S. W. A.*, Schola Botanica, p. 276. 1689. *Tournefort*, Inst. Rei Herb., **1**: 611. 1700. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Sumac S. Rhus Virginiana. *Parkinson*, Theatr. Bot., p. 1449. 1640. *Pluc'net.*, Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **3***: 56. 1704.

Virginische Gerberbaum. *Svinger.*, Theatr. Bot., p. 146. 1694.

Virginian Sumack. *Coles*, Adam in Eden, chapter 257. 1657.

RHUS JAVANICA L. Sp. Pl., ed. 1, 1: 265. 1753.

Rhus chinense. *Miller*, Gard. Dict., ed. 8, no. 7. 1768.

Rhus (Chinense) foliis pinnatis, foliolis ovatis, obtuse serratis, petiolo membranaceo villoso. *Miller*, Gard. Dict., ed. 8, no. 7. 1768.

Rhus foliis pinnatis, foliolis ovatis, obtuse serratis, petiolo membranaceo villoso. *Miller*, Gard. Dict., ed. 8, no. 7. 1768; ed. 7, no. 7. 1759.

Rhus foliis pinnatis ovatis acuminatis serratis, subtus tomentosis. *Linnaeus*, Sp. Pl. **1**: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759.

Rhus foliis pinnatis serratis, petiolis extimis internodiis, membranaceis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus javanicum. *Linnaeus*, Sp. Pl. **1**: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 3. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Rhus quinquifolia Sinarum lactescens, rachi medio alata, foliis molli hirsutie pubescentibus. *Pluc'net.*, Amaltheum, p. 183, 1705.

Rhus semialatum. *Martyn*, Gard. Dict., no. 8. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus sinarum lactescens, costa foliorum alata. *Miller*, Gard. Dict., ed. 8, no. 7. 1768; ed. 7, no. 7. 1759.

RHUS COPALLINA L. Sp. Pl., ed. 1, 1: 266. 1753. Lentiscus-leav'd sumach. Smooth sumach.

Arbor, quum Lentiscum nostram Europaeam, Virginiae plagis Indigenum esse contendere velint. *Pluc'net.*, Almagestum, p. 319. 1696.

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* "Dendrologiae."

Copalli-quahiutl. *Willdenow* in Linn. Sp. Pl. ed. 4, **1**: 1480. 1798.

Copalli-quahiutl Patlahoac, seu Arbore, Copalli latifolia. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Pluc'net.*, Almagestum, p. 319. 1696.

Copalli-quahiutl Topostlani. *Pluc'net.*, Almagestum, p. 319. 1696.

De CvItLacopalli seu Stercore Copallis. *Hernandez*, Rer. Med. Nov. Hisp., p. 48, 1651.

Forte etiam Aroeira Lusitania s. Lentiscus Promontorii Olindae. *Pluc'net.*, Almagestum, p. 319. 1696.

Gummi Copal. *Gronovius*, Flor. Virg., **2**: 148. 1743.

Lentisci Peruani similia Molle dicta. *Parkinson*, Theatr. Bot., p. 1524, 1640. *Pluc'net.*, Almagestum, p. 319. 1696.

Molle. *Pluc'net.*, Almagesti, p. 161. 1700.

Molle s. Lentisco Peruviana. *Pluc'net.*, Almagestum, p. 319. 1696.

Molli Petri Ciecae. *Pluc'net.*, Almagestum, p. 319. 1696.

Rhois obsoniorum similis Americana non serrata, rachi media alata. *Linnaeus*, Mat. Med., p. 50. 1749.

Rhus; Americanum; rachi, cui adnascuntur folia, rubra; folio lata, utrinque glabro, non serrato, Pistachiae simili. *Boerhaave*, Index Pl., **2**: 381. 1727.

Rhus Americanum, rachi (cui adnuscuntur folia) rubra, folio lata utrinque glabro non serrato, pistiachiae simili. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus Americanum rachi, cui folia adnascuntur, rubra foliis praecedenti angustioribus. *Boerhaave*, Index Pl., **2**: 381. 1727.

Rhus Americanum rachi, cui folia adnascuntur, rubra alata; foliis Molle Clusii brevioribus. *Boerhaave*, Index Pl., **2**: 381. 1727.

Rhus Copallinum. *Aiton*, Hort. Kew., **1**: 366. 1789. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Marshall*, Arbustr. Am., p. 128. 1785. *Martyn*, Gard. Dict., no. 9. 1807. *Miller*, Gard. Dict., ed. 8, no. 6. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus (Copallinum) foliis pinnatis integerrimis, petiolo membranaceo articulato. *Miller*, Gard. Dict., ed. 8, no. 6. 1768.

Rhus elatior foliis cum impari pinnatis, petiolis membranaceis articulatis, foliolis minoribus nonnunquam non exacte oppositis: racemis atrorubentibus. *Gronovius*, Flor. Virg., **2**: 148. 1743.

Rhus elatior, foliis impari-pinnatis, petiolis membranaceis articulatis. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

Rhus foliis pinnatis integerrimis, petiolo membranaceo articulato. *Aiton*, Hort. Kew. **1**: 366. 1789. *Linnaeus*, Sp. Pl. **1**: 266. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 6. 1768, (pr.p.); ed. 7, no. 6. 1759, (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1480. 1798.

Rhus foliis pinnatis, petiolo membranaceo articulato. *Linnaeus*, Mat. Med., p. 50. 1749.

Rhus foliis pinnatis, pedunculo communi membranaceo articulato. *Royen*. Flor. Leyd., p. 244. 1740. *Sauvages*, Meth. Fol., p. 227. 1751.

Rhus Obsoniorum similis Americana, Gummi candidum sundens non serrata, foliorum rachi medio alata. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Pluc'net.*, Almagestum, p. 318. 1696. *Royen*, Flor. Leyd., p. 244. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

?Rhus Obsoniorum similis Peruviana, serratis Fraxini pinnatis foliis, summa singulari pinna alas claudenti longius exporrecta. *Pluc'net.*, Almagestum, p. 319. 1696.

Rhus Virginianum Lentisci foliis. *Pluc'net.*, Almagestum, p. 318. 1696. *Ray*, Hist. Pl., **2**: 1799. 1688. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

Rhus Virginianum Lentisci foliis, Banisteri. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus Virginicum Lentisci foliis, Banisteri. *Gronovus*, Flor. Virg., **2**: 148. 1743.

Yztac-Quauxihotl alia Galiopifera. *Pluc'net.*, Almagestum, p. 318. 1696.

RHUS AROMATICA AITON. Arbustrum Americanum, p. 129. 1785. *(Schmaltzia crenata* (Mill.) Greene.) Aromatic sumach. Sweet sumach.

Myrica trifoliata foliis ternatis dentatis. *Printz*, Pl. Afr. Rar. in Linn. Amoen. Acad., **6**: 112. 1764.

Rhus aromaticum. *Aiton*, Hort. Kew.. **1**: 367. 1789. *Martyn*, Gard. Dict., no. 19. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus canadense. *Marshall*, Arbustr. Am., p. 129. 1785.

Rhus foliis ternatis: foliolis sessilibus ovato-rhombeis, inciso-serratis glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus foliis ternatis foliolis sessilibus cuneiformi-rhombeis, inciso-serratis glabris. *Aiton*, Hort. Kew., **1**: 368. 1789.

Rhus foliis ternatis: foliolis sessilibus ovato-rhombeis, inciso-serratis pilosiusculis. *Aiton*, Hort. Kew., **1**: 367. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus suaveolens. *Aiton*, Hort. Kew. **1**: 368. 1789. *Martyn*, Gard. Dict., no. 20, 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Toxicodendron crenatum. *Miller*, Gard. Dict., ed. 8, no. 5. 1768.

Toxicodendron (Crenatum) foliis ternatis, foliolis ovatis crenato-dentatis glabris. *Miller*, Gard. Dict., ed. 8, no. 5. 1768.

Toxicodendron foliis ternatis, foliolis ovatis crenato-dentatis glabris. *Miller*, Gard. Dict., ed. 8, no. 5. 1768; ed. 7, no. 5. 1759.

RHUS TOXICODENDRON L. Sp. Pl., ed. 1, 1: 266. 1753. (*Toxicodendron radicans* (L.) Kuntze.) Small-leav'd Poison-oak. Small leav'd Poison ivy.

Edera trifolia Canadensis. *Cornut*, Canad. Pl., pp. 996-98. 1635. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Martyn*, Gard. Dict., no. 18. 1807. *Royen*, Flor. Leyd., p. 244. 1740. *Tournefort*, Inst. Rei Herb., **1**: 61. 1700. *Willdenow* in Linn., Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus foliis ternatis: foliolis petiolatis angulatis pubescentibus. *Linnaeus*, Sp. Pl., **1**: 266. 1753, (pr.p.) *Linnaeus*, Syst. Nat., ed. 10, p. 963, (pr.p.).

Rhus foliis ternatis, foliolis petiolatis ovatis acutis integris. *Royen*, Flor. Leyd., p. 244. 1740, (pr.p.).

Rhus foliis ternatis: foliolis petiolatis ovatis nudis integerrimus, caule radicante. *Aiton*, Hort. Ups., **1**: 367. 1789. *Linnaeus*, Sp. Pl. **1**: 266. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Willdenow*, in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Rhus foliis ternatis, foliolis petiolatis, ovatis, acutis, integris. *Gronovius*, Flor. Virg., **1**: 33. 1739. *Royen*, Flor. Leyd., p. 244. 1740. *Sauvages*, Meth. Fol., p. 172. 1751.

Rhus foliis ternatis, foliolis petiolatis ovatis acutis pubescentibus, nunc integris, nunc sinuatis. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Sp. Pl. **1**: 265. 1753. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

? Rhus late scandens, foliis ternatis. *Colden*, Pl. Cold. Nov. Am., p. 105. 1742.

Rhus radicans. *Aiton*, Hort. Kew., **1**:367. 1789. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 17. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4., **1**: 1481. 1798.

Rhus radicans lucidum. *Aiton*, Hort. Kew., **1**: 367. 1789. *Martyn*, Gard. Dict., no. 17. 1807.

Rhus radicans opacum. *Aiton*, Hort. Kew., **1**: 367. 1789. *Martyn*, Gard. Dict., no. 17. 1807.

Rhus Toxicodendron. *Willdenow* in Linn. Sp. Pl., ed. 4., **1**: 1481. 1789, (pr.p.).

Rhus-Toxicodendron radicans. *Marshall*, Arbustr. Am., p. 131. 1785.

Rhus Toxicodendrum. *Linnaeus*, Sp. Pl. **1**: 266. 1753, (pr.p.). *Linnaeus*, Syst. Nat. ed. 10, p. 963. 1759, (pr.p.). *Martyn*, Gard. Dict., no. 18. 1807.

Toxicodendron amplexicaule, foliis minoribus glabris. *Aiton*, Hort. Kew., **1**: 367. 1789. *Dillenius*, Pl. Rar. Hort. Elth., p. 390. 1732. *Gronovius*, Flor. Virg., **1**: 33. 1739. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Martyn*, Gard. Dict., no. 17. 1807. *Miller*, Gard. Dict., ed. 8, no. 6. 1768; ed. 6, no. 5. 1752; ed. 2, no. 3. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Toxicodendron foliis ternatis, foliolis obcordatis, glabris, integerrimis, caule radicante. *Miller*, Gard. Dict., ed. 8, no. 1, 1768; ed. 7, no. 1, 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

Toxicodendron foliis ternatis, foliolis ovatis inciso-sinuatis glabris, caule volubili radicante. *Miller*, Gard. Dict., ed. 8, no. 6. 1768; ed. 7, no. 6. 1759.

Toxicodendron foliis ternatis, foliolis ovato-lanceolatis glabris caule erecto fruticoso. *Miller*, Gard. Dict., ed. 8, no. 3. 1768, ed. 7, no. 3. 1759.

Toxicodendron Glabrum. *Miller*, Gard. Dict., ed. 8, no. 3. 1768.

Toxicodendron (Glabrum) foliis ternatis, foliolis ovato-lanceolatis glabris caule erecto fruticoso. *Miller*, Gard. Dict., ed. 8, no. 3. 1768.

Toxicondendron rectum, foliis minoribus glabris. *Aiton*, Hort. Kew., **1**: 367. 1789. *Dillenius*, Pl. Par. Hort. Elth., p. 389. 1732. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Martyn*, Gard. Dict., no. 17, 1807. *Miller*, Gard. Dict., ed. 8, no. 3. 1768; ed. 7, no. 3. 1759; ed. 6, no. 3. 1752; ed. 2, no. 1. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, 1: 1481. 1798.

Toxicodendron scandens, foliis in eodem pediculo ternis pendulis reflexis, cortice inciso, serculis foliisve divulsis. *Gronovius*, Flor. Virg., **2**: 148. 1743.

Toxicodendron triphyllon, glabrum. *Tournefort*, Inst. Rei Herb., **1**: 611. 1700.

Toxicodendron triphyllum glabrum. *Boerhaave*, Index Pl., **2**: 381. 1727, (pr.p.). *Martyn*, Gard. Dict., no. 17. 1807. *Miller*, Gard. Dict., ed. 8, no. 2. 1768; ed. 7, no. 1. 1759; ed. 6, no. 1. 1752; ed. 1, no. 1. 1731. *Royen*, Flor. Leyd., p. 244. 1740. *Sauvages*, Meth. Fol., p. 172. 1751. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Toxicodendron volubis. *Miller*, Gard. Dict., ed. 8, no. 6. 1768.

Toxicodendron (Volubis) foliis ternatis, foliolis ovatis inciso-sinuatis glabris caule volubili radicante. *Miller*, Gard. Dict., ed. 8, no. 6. 1768.

Toxicodendron vulgare. *Martyn*, Gard. Dict., no. 17. 1807. *Miller*, Gard. Dict., ed. 8, no. 1. 1768, (pr.p.).

Toxicodendron (Vulgare) foliis ternatis, foliolis obcordatis glabris integerrimis, caule radicante. *Miller*, Gard. Dict., ed. 8, no. 1. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Toxicodendron vulgare latifolium. *Dillenius*, Pl. Rar. Hort. Elth., p. 389. 1732.

Toxicodendron glabrum. *Martyn*, Gard. Dict., no. 17, 1807.

RHUS QUERCIFOLIA (MICHX.*) STEUD.** Nomencl. Bot., p. 689. 1821. (*Toxicodendron quercifolia* (Michx.) Greene.) Poison-oak.

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* As *Rhus-Toxicodendron quercifolium*. Michaux, Andreas. Flora Boreali-Americana, sistens caracteres plantarum quas in America septentrionali collegit et detexit. 1803.

** As *Rhus quercifolia*. Steudel, Erneste. Nomenclator Botanicus Enumerans Ordine Alphabetico Nomina atque Synonyma tum generica tum specifica et a Linnaeo et recentioribus de re Botanica scriptoribus Plantis Phanerogamis imposita. 1821.

Apocynum, trifolium, Indicum, vulgo Epimedium. *Boerhaave*, Hist. Pl., p. 381. 1727.

Arbor, trifolia, venenata, Virginiana, folio hirsuto. *Boerhaave*, Index Pl., **2**: 381. 1727. *Linnaeus*, Sp. Pl. **1**: 266. 1753. *Ray*, Hist. Pl., **2**: 1799. 1688. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

? Hedera lactescens nunc recta nunc scandens trifoliata, folio querciformi. *Gronovius*, Flor. Virg., **1**: 33. 1739.

? Hedera surrecta triphylla, medio folio querciformi. *Gronovius*, Flor. Virg., **1**:33. 1739.

Hederae trifoliae Canadensi affinis Planta, peregrina, Arbor venenata, Quorundam. *Boerhaave*, Index Pl., **2**: 381. 1727.

Hederae trifoliae Canadensi affinis planta: Arbor venenata quorundam. *Tournefort*, Inst. Rei Herb., **1**: 611. 1700.

? Hederae trifoliae Canadensi affinis, surrecta, Arbor tinctoria, Virginia multis. *Boerhaave*, Index Pl., **2**: 381. 1727.

? Hedera trifolia, racemosa, Canadensis. *Barrel.*, Pl. Observ., p. 124. 1714.

Hedera trifolia Virginensis. *Boerhaave*, Index Pl., **2**: 381, 1727. Martyn, Gard. Dict., no. 18. 1807. *Parkinson*, Theatr. Bot., p. 1556. 1640.

Rhus foliis ternatis, foliolis ovatis inciso-angulatis pubescentibus. *Miller*, Gard. Dict., ed. 8, no. 2. 1768.

Rhus foliis ternatis: foliolis petiolatis angulatis pubescentibus. *Linnaeus*, Sp. Pl., **1**: 266. 1753, (pr.p.).

Rhus foliis ternatis: foliolis petiolatis angulatis pubescentibus, caule radicante. *Aiton*, Hort. Kew., **1**: 367. 1789.

Rhus foliis ternatis: foliolis petiolatis ovatis acutis pubescentibus: integris sinuatisque. *Linnaeus*, Hort. Ups., p. 68. 1748.

Rhus-Toxicodendron toxicodendrum. *Marshall*, Arbustr. Am., p. 131. 1785.

Rhus Toxicodendron. *Aiton*, Hort. Kew., **1**: 367. 1789, (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4., **1**: 1481. 1798, (pr.p.).

Rhus Toxicodendrum. *Linnaeus*, Sp. Pl., **1**: 266. 1753, (pr.p.). *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759, (pr.p.).

Toxicodendron foliis saepius ternatis, foliolis oblongo-ovato rugosis serratis, caule randicante. *Miller*, Gard. Dict., ed. 8, no. 7. 1768; ed. 7, no. 7. 1759.

Toxicodendron foliis ternatis, foliolis ovatis inciso-angulatis pubescentibus. *Miller*, Gard. Dict., ed. 8, no. 2. 1768; ed. 7, no. 2, 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Toxicodendron minus erectum capsularum tegumentum pilosis. *Gronovius*, Flor. Virg., **2**: 148. 1743.

Toxicodendron pubescens. *Martyn*, Gard. Dict., no. 18. 1807. *Miller*, Gard. Dict., ed. 8, no. 2. 1768, (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1481. 1798.

Toxicodendron (Pubescens) foliis ternatis, foliolis ovatis inciso-angulatis. *Miller*, Gard. Dict., ed. 8, no. 2. 1768. (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1482. 1798.

Toxicodendron serratum. *Miller*, Gard. Dict., ed. 8, no. 7. 1768.

Toxicodendron (Serratum) foliis saepium ternatis, foliolis oblongo-ovato rugosis serratis, caule radicante. *Miller*, Gard. Dict., ed. 8, no. 7. 1768.

Toxicodendron triphyllum, folio sinuato pubescente. *Barrel.*, Pl. Observ., p. 124. 1714. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Martyn*, Gard. Dict., no. 18. 1807. *Miller*, Gard. Dict., ed. 8, no. 1, 1768; ed. 7, no. 2. 1759; ed. 6, no. 2. 1752; ed. 1, no. 2, 1731. *Tournefort*, Inst. Rei Herb., **1**: 611. 1700. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Toxicodendron; triphyllum; folio sinuato, pubescente. *Boerhaave*, Index Pl., **2**: 381. 1727. *Linnaeus*, Hort. Ups., p. 68. 1748.

Vitis Canadensis. *Martyn*, Gard. Dict., no. 18. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Vitis, sylvestris, trifolia. *Boerhaave*, Index Pl., **2**: 381. 1727.

Vitis Sylvestris trifolia Canadensis. *Parkinson*, Theatr. Bot., p. 1556. 1640.

RHUS VERNIX L. Sp. Pl., ed. 1, 1:265. 1753. (*Toxicodendron Vernix* (L.) Kuntze.) Arbor Poyson-Wood tree. Varnish sumach. Poison sumach.

Amyris foliis impari pinnatis. *Miller*, Gard. Dict., ed. 8, no. 4. 1768.

Arbor americana, alatis foliis, fusco lacteo venenata. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl., **1**: 265. 1753. Pluc'net., Almagestum, p. 308. 1696. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus foliis pinnatis integerrimis. *Colden*, Pl. Cold. Nov. Am., p. 106. 1742. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Royen*, Flor. Leyd., p. 244. 1740. *Sauvages*, Meth. Fol., p. 227. 1751. *Willdenow* in Linn. Sp. Pl., ed. 4. **1**: 1479. 1798.

Rhus foliis pinnatis integerrimis annuis opacis, petiolo integro aequali. *Aiton*, Hort. Kew., **1**: 366. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus foliis pinnatis integerrimis (petiolo integro). *Linnaeus*, Mat. Med., p. 50. 1749, (pr.p.).

Rhus foliis pinnatis integerrimis, petiolo integro. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759.

Rhus foliis pinnatis integerrimis, petiolo integro aequali. *Miller*, Gard. Dict., ed. 8, no. 4. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus-Toxicodendron Vernix. *Marshall*, Arbustr. Am., p. 130. 1785.

Rhus Vernix. *Aiton*, Hort. Kew., **1**: 366. 1789. *Linnaeus*, Sp. Pl., **1**: 265. 1753, (excl. syn. Kaempf. Amoen.). *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 6. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798, (pr.p.).

Toxicodendron; Carolinianum, foliis pinnatis, floribus minimis herbaceis. *Miller*, Gard. Dict., ed. 1, no. 1. 1731. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1478. 1798.

Toxicodendron erectum procerum, foliis alatis, fructu rhomboide. *Gronovius*, Flor. Virg., **2**: 148. 1743.

Toxicodendron foliis alatis, Fructu Rhomboide. *Dillenius*, Pl. Rar. Hort. Elth., p. 390. 1732. *Gronovius*, Flor. Virg., **2**: 148. 1743. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl., **1**: 265. 1753. *Miller*, Gard. Dict., ed. 8, no. 4, 1768; ed. 7, no. 4, 1759; ed 6, no. 6. 1752; ed. 2, no. 4. 1740. *Royen*, Flor. Leyd., p. 244. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Toxicodendron foliis pinnatis, foliolis ovato-lanceolatis integerrimis. *Miller*, Gard. Dict., ed. 7, no. 4. 1759.

Toxicodendron pinnatis. *Miller*, Gard. Dict., ed. 3, no. 4. 1768.

Toxicodendron (Pinnatis) foliis pinnatis, foliolis ovato-lanceolatis integerrimis. *Miller*, Gard. Dict., ed. 8, no. 4. 1768.

Toxicodendron pinnatum. *Martyn*, Gard. Dict. no. 6. 1807.

Toxicodendron (pinnatum) foliis pinnatis, foliolis ovatolanceolatis integerrimis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

RHUS VERNICIFERA DC.* Prodromus, p. 68. 1825. (*Toxicodendron vernicifera* (DC.) Barkl. & Barkl.)

* de Candolle, Aug. Pyramo. Prodromus systematis naturalis regni vegetabilis, sive enumeratio contracta ordinum, generum, specierumque plantarum hucusque cognitarum, justa methodi naturalis normas digesta. 1825.

Arbor vernicifera legitima, folio pinnato Juglandis, fructu racemoso ciceris facie. *Kaempfer*, Amoen. Exot., p. 791. 1712.

Sitz s. Sitz-dsiu. *Linnaeus*, Sp. Pl. **1**: 266. 1753.

Sitz, vel Sitz-diu. *Linnaeus*, Mat. Med., **1**: 50. 1749.

Sitz, vel Sitz dsju, i.e. Sitz planta, vulgo Urus seu Urus no ki. *Kaempfer*, Amoen. Exot., p. 791. 1712.

RHUS SUCCEDANEA L.* Mantissa, 2: 221. 1767. *(Toxicodendron succedanea* (L.) Kuntze)

Arbor vernicifera spuria, sylvestris, angustifolia. *Kaempfer*, Amoen. Exot., p. 793. 1712, *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Fari no ki. *Kaempfer*, Amoen. Exot., p. 793. 1712.

Rhus foliis pinnatis integerrimis perennantibus lucidis, petiolo integro aequali. *Aiton*, Hort. Kew., **1**: 366. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Rhus succedaneum. *Aiton*, Hort. Kew., **1**: 366. 1789. *Martyn*, Gard. Dict., no. 7. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1479. 1798.

Toxicodendron Altissimum. *Martyn*, Gard. Dict., no. 7. 1807. *Miller*, Gard. Dict., ed. 8, no. 10. 1768.

Toxicodendron (Altissimum) foliis pinnatis sessilibus, lobis acuminatis. *Miller*, Gard. Dict., ed. 8, no. 10. 1768.

Toxicodendron foliis pinnatis sessilibus, lobis acuminatis. *Miller*, Gard. Dict., ed. 8, no. 10. 1768.

RHUS ROSMARINIFOLIA VAHL. Symb. Bot., 3:50. 1794.

Frutex Africanus Rosmarini foliis, baccifer, flore viridi odorato, ubi natatur, quod in locis crescat saxasis ad duorum pedum altitudinem florens Septembri. *Burman*, Rar. Afr. Pl., p. 251. 1738-9.

Rhus Africanum, longo et angusto folio subtus incano, non crenato. *Burman*, Rar. Afr. Pl., p. 251. 1738-9. *Ray*, Hist. Pl., **3**: 56**. 1704.

Rhus Africanum strictissimus foliis trifoliatum. *Burman*, Rar. Afr. Pl., p. 251. 1738-9. *Pluc'net.*, Amaltheum, p. 183. 1705.

Rhus Africanum trifoliatum, latis Rosmarini foliis, subtus argenteis. *Pluc'net.*, Amaltheum, p. 183. 1705.

Rhus foliis ternatis: foliolis sessilibus linearibus revolutis subtus ferrugineis. *Vahl*, Symb. Bot., **3**: 50. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus fruticosum, foliis trifidis linearibus, acuminatis. *Burman*, Rar. Afr. Pl., p. 251. 1738-9. *Linnaeus*, Sp. Pl. **1**: 267. 1753. *Vahl*, Symb. Bot., **3**: 50. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus rosmarinifolium. *Martyn*, Gard. Dict., no. 30. 1807. Vahl, Symb. Bot., **3**: 50. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rosmarini foliis, ternis, angustis frutescens planta Africana, floribus spicatis, pentapetalis, minimus, cujus et minor ibi notatur varietas. *Burman*, Rar. Afr. Pl., p. 251. 1738-9.

RHUS ANGUSTIFOLIA L. Sp. Pl., ed. 1, 1: 267. 1753. Narrow-leav'd sumach.

Negunda mare Acostae habet, minus recte. *Ray*, Hist. Pl. **3****: 56. 1704.

Rhus Africanum trifoliatum, foliis serratis. *Ray*, Hist. Pl., **3****: 56. 1704.

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* Linnaeus, Carl. Mantissa plantarum. 1767.

** "Dendrologiae."

Rhus Africanum trifoliatum majus foliis subtus argentiis, acutis et margine incisis. *Pluc'net.*, Almagestum, p. 319. 1696. *Ray*, Hist. Pl., 3*: 56. 1704. *Royen*, Flor. Leyd., p. 244. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, 1: 1494. 1798.

Rhus; Africanum; trifoliatum; majus; foliis subtus argenteis, acutis, et margine incisis. *Boerhaave*, Index Pl., **2**: 381. 1727. *Linnaeus*, Sp. Pl. **1**: 267. 1753. *Miller*, Gard. Dict., ed. 8, no. 12. 1768; ed. 7, no. 12, 1759; ed. 1, no. 3. 1731.

Rhus Africanum trifoliatum majus, foliis subtus argenteis acutis, margine incisis. *Miller*, Gard. Dict., ed. 6, no. 6. 1752.

Rhus angustifolium. *Aiton*, Hort. Kew., **1**: 369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753, (pr.p.). *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 29. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus Argenteum. *Martyn*, Gard. Dict., no. 29. 1807. *Miller*, Gard. Dict., ed. 8, no. 12. 1768.

Rhus (Argenteum) foliis ternatis, foliolis petiolatis lineari-lanceolatis integerrimis subtus tomentosus. *Miller*, Gard. Dict., ed. 8, no. 12. 1768.

Rhus foliis ternatis, foliolis lineari-lanceolatis petiolatis integerrimis. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus foliis ternatis, foliolis petiolatis lneari-lanceolatis integerrimis subtus tomentosis. *Aiton*, Hort. Kew., **1**: 369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 12. 1768; ed. 7, no. 12. 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

RHUS TOMENTOSA L. Sp. Pl., ed. 1, 1: 266. 1753. Woolly-leav'd sumach.

Negunda Mas. *Commelin.*, Hort. Med. Amst., p. 179. 1697. *Pluc'net.*, Almagesti, p. 161. 1700.

Rem-Nosi. *Commelin.*, Hort. Med. Amst., p. 179. 1697.

Rhus foliis ternatis, foliolis ovatis utrinque acutis dentatis petiolatis. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus foliis ternatis: foliolis ovatis utrinque dentatis: lateralibus petiolatis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis: foliolis ovatis utrinque acutis dentatis: lateralibus petiolatis. *Linnaeus*, Sp. Pl., **1**: 226. 1753.

Rhus foliis ternatis: foliolis petiolatis ovatis acutis dentatis. *Linnaeus*, Sp. Pl., **1**: 266. 1753.*Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis, foliolis subpetiolatis rhombeis angulatis subtus tomentosis. *Aiton*. Hort. Kew., **1**: 368. 1789. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 9. 1768; ed. 7, no 9. 1759, (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus sive Sumach Africanum trifolium, hirsutum et crenatum. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus tomentosum. *Aiton*, Hort. Kew., **1**: 368. 1789. *Linnaeus*, Sp. Pl., **1**: 266. 1753, (pr.p.). *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict., no. 25. 1807. *Miller*, Gard. Dict., ed. 8, no. 9. 1768, (pr.p.). *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1789, (pr.p).

Rhus (Tomentosum) foliis ternatis foliolis subpetiolatis, rhombeis angulatis, subtus tomentosis. *Miller*, Gard. Dict., ed. 8, no. 9. 1768, (pr.p.).

Vitex trifolia minor indica serrata. *Commelin.*, Hort. Med. Amst., p. 179. 1697. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Martyn*, Gard. Dict., no. 25. 1807. *Pluc'net.*, Almagesti, p. 161. 1700. *Ray*, Hist. Pl., **3***: 56. 1704. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

* "Dendrologiae."

RHUS INCISA L. *fil.* Suppl. Pl. Syst., p. 183. 1781.

Rhus foliis ternatis, foliolis inciso-pinnatifidis subtus tomentosis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis: foliolis sessilibus cuneiformibus inciso-pinnatifidis subtus tomentosis venosis, calycibus tomentosis. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1483. 1798.

Rhus incisum. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Martyn*, Gard. Dict., no. 24. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

RHUS LUCIDA L. Sp. Pl., ed. 1, 1: 267. 1753. Shining-leav'd sumach.

Cara-Nosi. *Commelin.*, Hort. Med. Amst., p. 181. 1697. *Pluc'net.*, Almagesti, p. 161. 1700. *Ray*, Hist. Pl., **3***: 56. 1704.

Lentiscus Africana trifolia humilis. *Burman*, Rar. Afr. Pl., p. 251. 1738-9.

Lentiscus Africana triphyllos Quorundum. *Pluc'net.*, Almagestum, p. 319. 1696.

Lentiscus humilis trifolia Africanis. *Pluc'net.*, Almagesti, p. 161. 1700.

Negunda foemina. *Commelin.*, Hort. Med. Amst., p. 181. 1697. *Pluc'net.*, Almagesti, p. 161. 1700.

Negunda foemina Acostae ex sententia. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifoliatum majus folio rotundo glabra. *Burman*, Rar. Afr. Pl., p. 251. 1738-9.

Rhus Africanum trifoliatum minus, glabrum, splendente folio rotundo, integro. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifoliatum minus glabrum, splendente folio subrotundo, integro. *Boerhaave*, Index. Pl., **2**:381. 1727. *Linnaeus*, Hort. Ups., p. 68. 1748. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Miller*, Gard. Dict., ed. 8, no. 10. 1768; ed. 7, no. 10. 1759. *Pluc'net.*, Almagestum, p. 319. 1696. *Royen*, Flor. Leyd., p. 244. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus; Africanum, trifoliatum, minus, glabrum, splendente folio subrotundo, integro forte Lentiscus Africanus triphyllos quorundam. *Miller*, Gard. Dict., ed. 1, no. 4. 1731.

Rhus arboreum trifoliatum latifolium. *Aiton*, Hort, Kew., **1**: 369. 1789. *Burman*, Rar. Afr. Pl., p. 251. 1738. *Linnaeus*, Sp. Pl., **1**: 273. 1753. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1485. 1798.

Rhus foliis ternatis, foliolis cuneiformibus, sessilibus. *Royen*, Flor. Leyd., p. 244. 1740.

Rhus foliis ternatis, foliolis obovatis retusis glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus foliis ternatis: foliolis obverse cordatis sessilibus. *Linnaeus*, Hort. Ups., p. 68. 1748.

Rhus foliis ternatis, foliolis sessilibus cuneiformibus laevibus. *Aiton*, Hort. Kew., **1**:369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Linnaeus*, Syst. Nat., ed. 10. p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 10. 1768; ed. 7, no. 10. 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus lucidum. *Aiton*, Hort. Kew., **1**: 369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Linnaeus*, Syst. Nat., ed. 10. p. 963. 1759. *Martyn*, Gard. Dict., no. 32. 1807. *Miller*, Gard. Dict., ed. 8, no. 10. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus (Lucidum) foliis ternatis, foliolis sessilibus cuneiformibus laevibus. *Miller*, Gard. Dict., ed. 8, no. 10. 1768.

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* "Dendrologiae."

Vitex trifolia minor Indica rotundifolia. *Aiton*, Hort. Kew., **1**:369. 1789. *Commelin.*, Hort. Med. Amst., p. 181. 1697. *Linnaeus*, Hort. Ups., p. 68, 1748. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Martyn*, Gard. Dict., no. 32. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Vitex trifolia minor Indica rotundi folia. *Pluc'net.*, Almagesti, p. 161. 1700.

RHUS AFRICANA MILL. Gard. Dict., ed. 8, no. 11. 1768.

Rhus Africanum. *Miller*, Gard. Dict., ed. 8, no. 11. 1768.

Rhus (Africanum) foliis ternatis, foliolis ovatis nervosis, marginibus saepius dentatis, utrinque viridibus. *Miller*, Gard. Dict., ed. 8, no. 11. 1768.

Rhus; Africanum; trifoliatum; majus; glabrum; splendente utrinque folio, subrotundo, medio quandoque crenato. *Boerhaave*, Index Pl., **2**: 381. 1727. *Miller*, Gard. Dict., ed. 8, no. 11, 1768; ed. 7, no. 11. 1759.

Rhus foliis ternatis, foliolis ovatis nervosis, marginibus, saepius dentatis, utrinque viridibus. *Miller*, Gard. Dict., ed. 8, no. 11. 1768; ed. 7, no. 11. 1759.

RHUS RIGIDA MILL. Gard. Dict., ed. 8, no. 14. 1768.

Rhus foliis ternatis linearibus integris rigidis glabris. *Miller*, Gard. Dict., ed. 8, no. 14. 1768.

Rhus Rigidum. *Miller*, Gard. Dict., ed. 8, no. 14. 1768.

Rhus (Rigidum) foliis ternatis linearibus integris rigidis glabris. *Miller*, ed. 8, no. 14. 1768.

RHUS CUNEIFOLIA L. *fil.* Suppl. Pl. Syst., p. 183. 1781.

Rhus cuneifolium. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Martyn*, Gard. Dict., no. 23. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus foliis ternatis, foliolis cuneiformibus septemdentatis glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis, foliolis sessilibus cuneiformibus glaberrimis septemdentatis, dentibus mucronatis. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

RHUS SINUATA THUNB. Prodr. Pl. Cap., p. 52. 1794 (non Echl. & Zegh.)*

Rhus foliis ternatis, foliolis ovatis obtusis sinuatis subtus villosis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus sinuatum. *Martyn*, Gard. Dict., no. 22. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

RHUS DENTATA THUNB. Prodr. Pl. Cap., p. 52. 1794.

Rhus sinatum. *Martyn*, Gard. Dict., no. 22. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

Rhus foliis ternatis, foliolis obovatis mucronato-dentatis glabris, caule scabro. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1482. 1798.

* Probably conspecific with *Rhus mysurensis* Heyne fide Schonland.

RHUS PENTAPHYLLA DESF.* Fl. Atlant., p. 267. 1798.

Rhamnus pentaphyllus. *Linnaeus*, Syst. Nat., ed. 12, **2**: 179. 1767.

Rhamnus siculus. *Linnaeus*, Syst. Nat., ed. 12, **2**: 179. 1767.

Rhus siculus. pentaphyllus. *Ray*, Hist. Pl. **2**: 1626. 1688.

Rhus spinis terminalibus, foliolis ternatis quinatisque. *Linnaeus*, Syst. Nat., ed. 12, **2**: 179. 1767.

RHUS LANCEA L. *fil.* Suppl. Pl. Syst., p. 183. 1781. Willow-leav'd sumach.

Rhus foliis lineari-lanceolatis integerrimis glabris, basi attenuatis: intermedio subpetiolato. *Vahl*, Symb. Bot., **3**: 50. 1794.

Rhus foliis ternatis, foliolis lanceolatis integris glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus foliis ternatis: foliolis lanceolato-subulatis elongatis utrinque glaberrimis. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus foliis ternatis, foliolis lineari-lanceolatis integerrimis glabris basi attenuatis, intermedio subpetiolato. *Aiton*, Hort. Kew., **1**: 368. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus lanceum. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794.

Rhus (Lanceum) follis ternatis, foliolis lanceolatis integris glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus (lanceum) foliis ternatis, foliolis lanceolato-subulatus elongatus utrinque glaberrimis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus viminale. *Aiton*, Hort. Kew., **1**: 368. 1789. *Martyn*, Gard. Dict., no. 28. 1807. *Vahl*, Symb. Bot., **3**: 50. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

RHUS LAEVIGATA L. Sp. Pl., ed. 2, 2: 1672. 1763 (non Thunb.) Smooth Leav'd sumach.

Rhus Africanum trifolium majus, folio subrotundo integro, molli et incano. *Aiton*, Hort. Kew., **1**: 368. 1789. *Boerhaave*, Index Pl., **2**: 381. 1727. *Burman*, Rar. Afr. Pl., p. 251. 1738-9. *Miller*, Gard. Dict., ed. 8, no. 8. 1768; ed. 7, no. 8. 1759; ed. 6, no. 8. 1752; ed. 1, no. 4. 1731. *Pluc'net.*, Almagestum, p. 319. 1696. *Ray*, Hist. Pl. **3****: 56. 1704. *Willdenow* in Linn., Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus Africanum trifoliatum majus, foliis obtusis & incisis, hirsutie pubescentibus. *Boerhaave*, Index Pl., **2**: 381. 1727. *Linnaeus*, Sp. Pl., **1**: 266. 1753. *Miller*, Gard. Dict., ed. 8, no. 9. 1768; ed. 7, no. 9. 1759. *Pluc'net.*, Almagestum, p. 319. 1696. *Ray*, Hist. Pl., **3****: 56. 704. *Royen*, Flor. Leyd., p. 244. 1740. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**:1483. 1798.

Rhus Capensis trifoliata, villosa, integra. *Burman*, Rar. Afr. Pl., p. 251. 1738-9. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus caule pubescente, foliis ternatis; foliolis sessilibus ovatis integris pubescenti-villosis. *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis, foliolis obovatis integerrimis sessilibus utrinque pilosis. *Aiton*, Hort, Kew., **1**:368. 1789. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis, foliolis ovatis acuminatis integris glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

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* Desfont, Réné Louiche. Flora atlantica sive historia plantarum, quae in Atlante, agro Tunetano et Algeriense crescunt. 1798-1800.

** "Dendrologiae."

Rhus foliis ternatis, foliolis ovatis integris villosis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

Rhus foliis ternatis, foliolis ovatis subtus tomentosis. *Miller*, Gard. Dict., ed. 8, no. 8. 1768; ed. 7, no. 8. 1759.

Rhus foliis ternatis: foliolis sessilibus lanceolatis laevibus. *Aiton*, Hort. Kew., **1**: 368. 1789. *Linnaeus*, Sp. Pl., ed. 2, **2**: 1672. 1763. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus incanum. *Martyn*, Gard. Dict., no. 26. 1807. *Miller*, Gard. Dict., ed. 8, no. 8. 1768. (Non. Engler.)

Rhus (Incanum) foliis ternatis, foliolis ovatis subtus tomentosis. *Miller*, Gard. Dict., ed. 8, no. 8. 1768.

Rhus laevigatum. *Aiton*, Hort. Kew., **1**: 368. 1794. *Linnaeus*, Sp. Pl., ed. 2, **2**: 1672. 1763. *Martyn*, Gard. Dict., no. 27. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus villosum. *Aiton*, Hort. Kew., **1**: 368. 1789, (pr.p.). *Linné, fil.*, Suppl. Pl. Syst., p. 183. 1781. *Martyn*, Gard. Dict., no. 26. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1483. 1798.

RHUS LEGATI SCHONL. Bothalia, 3: 51. 1930.

Rhus laevigata *Thunb.*, Prodr. Pl. Cap., p. 52. 1794.

RHUS PUBESCENS THUNB. Prodr. Pl. Cap., p. 52. 1794 (? *Rhus MacOwani* Schonl.) (*Rhus mucronata* Thunb. emend. Schonl.)

Rhus foliis ternatis, foliolis obovatis mucronatis glabris, ramis villosis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus pubescens. *Martyn*, Gard. Dict., no. 27. 1807. *Thunberg*, Prodr. Pl. Cap., p. 52. 1794. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1484. 1798.

Rhus Cotinus L.* Sp. Pl., ed. 1, 1: 267. 1753. (COTINUS COGGYGRIA SCOP.**) Venus's sumach.

Chrysophyllon priscotum. *l'Obel*, Icones Stirp., **2**: in *Index synonymicus*. 1591.

Coccigyra sive Cotinus putata. *Tournefort*, Inst. Rei Herb., **1**: 610. 1700.

Coccigria Theophrasti. *Bauhin*, Pinax, p. 415. 1623. *l'Obel*, Icones Stirp., **2**: 99. 1591.

Cocconilea Coccygria. *Martyn*, Gard. Dict., no. 33. 1807.

Cocconilea sive Coggygria. *Bauhin*, Pinax, p. 415. 1623. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Ray*, Hist. Pl., **2**: 1696. 1688. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Coggygria Plinii. *Bauhin*, Pinax, p. 415. 1623.

Coggygria sive Cotinus Coriaria. *Parkinson*, Theatr. Bot., p. 1450. 1640. *Ray*, Hist. Pl., **2**: 1696. 1688.

Coggygria sive Cotinus putata. *Bauhin*, Pinax, p. 415. 1623. *Boerhaave*, Index Pl., **2**: 380. 1727. *Martyn*, Gard. Dict., no. 33. 1807. *Ray*, Hist., Pl., **2**: 1696. 1688. *Royen*, Flor. Leyd., p. 243. 1740.

Coggygria Theophrasti. *Bauhin*, Pinax, p. 415. 1623. *Barrel.*, Pl. Observ., p. 124. 1714. *Martyn*, Gard. Dict., no. 33. 1807.

Coggygria Theophrasti, vel Cotinus coriarius Plinii. *Ray*, Hist. Pl., **2**: 1696. 1688.

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* Also variously known in early writings as: Gelb Presilgholk, Coccygyria Plinii, and Coreigria.

** Scopoli, Ioannis Antonii. Flora Carniolica exhibens Plantas Carnioliae Indigenas, ed. 2, **1**: 220. 1772.

Coreigria, forte Barba jovis Plinii. *Bauhin*, Pinax, p. 415. 1623.

Cotinus, Scotano, & Roso. *Camerarius*, Deplantis Ep. Util., p. 123. 1584.

Cotinus Coccygria. *Martyn*, Gard. Dict., no. 33. 1807.

Cotinus Coggygria. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Cotinus Coriaria. *Barrel.*, Pl. Observ., p. 124. 1714. *Boerhaave*, Index Pl., **2**: 380. 1727. *Dodon.*, Stirp. Hist. Pemp. Sex, p. 769. 1583. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Martyn*, Gard. Dict., no. 33. 1807. *Miller*, Gard. Dict., ed. 7, no. 15. 1759; ed. 1, no. 1. 1731. *Royen*, Flor. Leyd., p. 243. 1740. *Sauvages*, Meth. Fol., p. 306. 1751. *Tournefort*, Inst. Rei Herb., **1**: 610. 1700. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Cotinus Coriaria Plinii. *Gerarde*, Herball, p. 1293. 1597.

Cotinus Coriarius. *Martyn*, Gard. Dict., no. 33. 1807.

Cotinus foliis obverse ovatis. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Miller*, Gard. Dict., ed. 6, no. 1. 1752. *Royen*, Flor. Leyd., p. 243. 1740. *Sauvages*, Meth. Fol., p. 306. 1751. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Cotinus Plinii. *Barrel.*, Pl. Observ., p. 124. 1714. *Bauhin*, Pinax, p. 415. 1623. *l'Obel*, Icones Stirp., **2**: in *Index synonymicus*. 1591.

Cotinus Theophrasti. *Gerarde*, Herball, p. 1293. 1597. *Martyn*, Gard. Dict., no. 33. 1807.

De Cotino Coriaria. *Dodon.*, Stirp. Hist. Pemp. Sex, p. 767. 1583.

Rhus Allobrogum. *l'Obel*, Icones Stirp., **2**: in *Index synonymicus*. 1591.

Rhus Cotinus. *Aiton*, Hort. Kew., **1**: 369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard Dict., no. 33. 1807. *Miller*, Gard. Dict., ed. 8, no. 15. 1768. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus (Cotinus) foliis simplicibus obovatis. *Miller*, Gard. Dict., ed. 8, no. 15. 1798.

Rhus foliis simplicibus obovatis. *Aiton*, Hort. Kew., **1**: 369. 1789. *Linnaeus*, Sp. Pl., **1**: 267. 1753. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Miller*, Gard. Dict., ed. 8, no. 15. 1768; ed. 7, no. 15. 1759. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Rhus racemis plumosis, foliis ovatis. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1485. 1798.

Scotanum vulgo. *Bauhin*, Pinax, p. 415. 1623. *Caesalpinus*, De Plantis, p. 75. 1583.

Venice Sumack. *Coles*, Adam in Eden, chapter 257. 1657.

Rhus Metopium Elmgren. Pug. Jam. Pl., in Linn. Amoen. Acad. 5: 395. (1759,) 1760. (METOPIUM BROWNEI (JACQ.*) URB.**

Borbonia fructo corallino, flore pentapetalo. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

Borbonia fructu globoso, nigro calyce e viride rubente. *Plumier*, Nov. Pl. Am., p. 3. 1703.

Borbonia fructu oblongo, nigro, calyce coccinea. *Plumier*, Nov. Pl. Am., p. 3. 1703.

Metopium foliis subrotundo pinnato-quinatis, racemis alaribus. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

Rhus foliis pinnatis quinatis integerrimis ovatis glabris. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759.

Rhus foliis pinnatis quinatis integerrimis subrotundis glabris. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

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* Jacquin, Enumeratio Systematica Plantarum, p. 18. 1760.

** Urban, Ign., Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis, **5**: 402. 1908.

Rhus Metopium. *Elmgren*, Pug. Jam. Pl., in Linn. Amoen. Acad. **5**: 395. 1760. *Linnaeus*, Syst. Nat., ed. 10, p. 963. 1759. *Martyn*, Gard. Dict. no. 12. 1807. *Willdenow* in Linn. Sp. Pl., ed. 4, **1**: 1480. 1798.

? Terebinthus Americana, pistacia fructu non eduli. *Sloane*, Jam. Nat. Hist., **2**: 90. 1725.

Terebinthus Brovvnii. *Jacquin*, Enumeratio Systematica Plantarum, p. 18. 1760.

Terebinthus maxima. *Elmgren*, Pug. Jam. Pl., in Linn. Amoen. Acad. **5**: 395. 1760.

Terebinthus Americana polyphylla. *Ray*, Hist. Pl., **3***: 50. 1704.

Terebinthus maxima pinnis paucioribus, majoribus atque rotundioribus, fructu racemoso sparso. *Ray*, Hist. Pl., **3***: 50. 1704. *Sloane*, Cat. Pl., **1**: 167. 1696. *Sloane*, Jam. Nat. Hist., **2**: 90. 1725.

Therebinthus americana polyphylla. *Commelin.*, Hort. Med. Amst., p. 149. 1697.

Doubtful Names**

Rhus Africanum trifolium angustissimo folio, subtus incano, seu Angi casti lobis. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifolium, foliis brevioribus, nervosis, superne glabris et splendentibus, subtus incanus. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifoliatum, foliis longissimus. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifoliatum, foliis oblongis ex angusta principio in apecum disenentibus. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifoliatum latissimo folio, parte aversa incano. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus; Africanum; trifoliatum; majus; foliis acutioribus, argutius denticulatis, glabris, subtus argenteis. *Boerhaave*, Index Pl., **2**: 381. 1727.

Rhus: Africanum; trifoliatum; majus; foliis acutioribus, incisis, supra viridibus, glabris, infra argenteis, glabris. *Boerhaave*, Index Pl., **2**: 381. 1727.

Rhus Africanum trifoliatum majus, splendente folio rotundo, integro, priori omnibus partibus majus est. *Ray*, Hist. Pl., **3***: 56. 1704.

Rhus Africanum trifolium minus glabrum, splendente folio subrotundo integro; forte Lentiscus Africanus triphyllos quorundam. *Miller*, Gard. Dict., ed. 6, no. 7. 1752.

Rhus Chusan Sorbi folio vix serrato, rachi alata. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Capensis foliata trifidis latioribus serratis subtus albidus. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Capensis trifoliata angustifolia subtus alba. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Capensis trifoliata laevis major. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Capensis trifoliata laevis minor. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Capensis trifoliata villosa, serrata. *Petiver* (in Ray, Hist. Pl., **3**:) 241. 1704.

Rhus Floridana minor, Clematis Conterrheni foliis, subtus lanatus. *Pluc'net.*, Amaltheum, p. 183. 1705.

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* "Dendrologiae."

** These names were applied in such a manner, with neither sufficient description, sufficiently clear illustrations, nor reference to accessible specimens, so that it has been impossible to identify the names with any particular species of *Rhus*, and in some cases to either definitely exclude or include them in this group, truly *nomina omnia dubia*.

Rhus foliis ternatis, lineari-lanceolatis integerrimis sessilibus utrinque viridibus. *Miller*, Gard. Dict., ed. 7, no. 13. 1759.

Rhus trifoliatum Brasilianum, foliis glabris. *Pluc'net.*, Amaltheum, app., 1705.

Excluded Names*

Cotinus foliis obverse cordatis.
Forte Quauhte copalli Pitzahuac, Copallifera leptiphylla alia.
Rhois trifoliatae facie Frutex Salawaccensis, floribus juliformibus.
Rhus alatum.
Rhus atrum.
Rhus cirrhiflorum.
Rhus Cobbe.
Rhus Cominia.
Rhus dimidiatum.
Rhus digitatum.
Rhus foliis pinnatis, foliolis alternis decurrentibus cuneiformibus apice serratis, panicula sessili pauciflora.
Rhus foliis pinnatis, foliolis alternis decurrentibus serratis.
Rhus foliis pinnatis, foliolis ovatis apice serratis, petiolatis internodiis omnibus alatis.
Rhus foliis quinatis, caule scandente cirrhifero.
Rhus foliis simplicibus ovato-oblongis, floribus polygamis.
Rhus foliis ternatis, foliolis obovatis tridentatis glabris, caule cirrhifero scandente.
Rhus foliis ternatis, foliolis ovatis acuminatis integerrimis, petiolatis, floribus paniculatis terminalibus.
Rhus foliis ternatis: foliolis ovatis acuminatis serratis, pedunculatis tomentosis.
Rhus foliis ternatis, foliolis ovatis mucronatis integris glabris, caule cirrhis scandente.
Rhus foliis ternatis, foliolis petiolatis ovatis subtus tomentosis remotissime serratis.
Rhus herba Plinii.
Rhus myrtifolius.
Rhus myrtifolia Monspeliaca.
Rhus Obsoniorum similis leptiphyllos, Tragodes, Americana spinosa, rachi medio appendicibus aucto.
Rhus Plinii myrtifolia Monspeliensium.
Rhus Plinio putata.
Rhus Radaelijawel.
Rhus scandens, foliis pinnatis, foliolis oblongis integerrimis glaberrimis.
Rhus scandens, foliis ternatis, foliolis incanis serratis, serraturis tribus ad quinque.
Rhus scandens, foliis ternatis, foliolis integerrimis glabris.
Rhus sylvestris altera.
Rhus sylvestris Plinii.
Rhus tridentatum (Thunb., non Sond.)
Rhus virginianum folio myrti.
Rhus Zeylonicus trifoliatus, phaseoli facie, floribus compiosis spicatis.
Toxicodendron arboreo.
Toxicodendron arborescens.
Toxicodendron arborescens pyri foliis glabris, floribus racemosis.
Toxicodendron foliis ternatis foliolis lanceolatis superne inaequaliter serratis, subtus tomentosis, caule arborescente.
Toxicodendron foliis ternatis, foliolis ovato-lanceolatis acuminatis glabris, caule fruticoso ramoso.
Toxicodendron rectum pentaphyllum glabrum, foliis latioribus.

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* While these names employ *Rhus* or its commoner synonyms, as the generic name, the plants to which they have been given have been shown in all cases to belong to other groups.

Index of PreLinnaean Synonymy in Rhus

Apocynum, trifolium, indicum, vulgo Epimedium= Rhus quercifolia (Michx.) Steud.
Arbor americana, alatis foliis, fusco lacteo venenata= Rhus Vernix L.
Arbor, quum Lentiscum nostram Europaeam, Virginiae plagis Indigenum esse contendere velint= Rhus Copallina L.
Arbor, trifolia, venenata, Virginiana, folio hirsuto= Rhus quercifolia (Michx.) Steud.
Arbor vernicifera legitima, folio pinnato Juglandis, fructu racemoso ciceris facie= Rhus vernicifera DC.
Arbor vernicifera spuria, sylvestris, angustifolia= Rhus succedanea L.
Borbonia fructo corallino, flore pentapetalo= Metopium Brownei (Jacq.) Urb.
Borbonia fructu globoso, calyce e viride rubente= Metopium Brownei (Jacq.) Urb.
Borbonia fructu oblongo, calyce coccinea= Metopium Brownei (Jacq.) Urb.
Cara-Nosi= Rhus lucida L.
Chrysophyllon priscotum= Cotinus Coggygria Scop.
Coccigria Theophrasti= Cotinus Coggygria Scop.
Coccigria sive Cotinus putata= Cotinus Coggygria Scop.
Cocconilea sive Coggygria= Cotinus Coggygria Scop.
Cocconilea Coccygria= Cotinus Coggygria Scop.
Coggygria Plinii= Cotinus Coggygria Scop.
Coggygria sive Cotinus Coriaria= Cotinus Coggygria Scop.
Coggygria sive Cotinus putata= Cotinus Coggygria Scop.
Coggygria Theophrasti= Cotinus Coggygria Scop.
Coggygria Theophrasti, vel Cotinus coriarius Plinii= Cotinus Coggygria Scop.
de CoItLacopalli seu Stercore Copallis= Rhus Copallina L.
Copalli latifolia= Rhus Copallina L.
Copalli-quahiutl= Rhus Copallina L.
Copalli-quahiutl Patlahoac, sue arbor. Copalli latifolia= Rhus Copallina L.
Copalli-quahiutl Topostlani= Rhus Copallina L.
Coreigria, forte Barba joves Plinii= Cotinus Coggygria Scop.
Coriare Sumack= Rhus Coriaria L.
De Cotino Coriaria= Cotinus Coggygria Scop.
Cotinus= Cotinus Coggygria Scop.
Cotinus, Scotano, et Roso= Cotinus Coggygria Scop.
Cotinus Coccygria= Cotinus Coggygria Scop.
Cotinus Coggygria Scop., see page 316.
Cotinus Coriaria= Cotinus Coggygria Scop.
Cotinus coriarius= Cotinus Coggygria Scop.
Cotinus foliis obverse ovatis= Cotinus Coggygria Scop.
Cotinus Plinii= Cotinus Coggygria Scop.
Cotinus Theophrasti= Cotinus Coggygria Scop.
Edera trifolia Canadensis= Rhus Toxicodendron L.
Fari no ki= Rhus succedanea L.
Forte etiam Aroeira Lusitania s Lentiscus Promontorii Olindae= Rhus Copallina L.
Frutex Africanus Rosmarini foliis, baccifer, flore viridi odorato, ubi natatur, quod in locis crescat saxasis ad duorum pedum altitudinem florens septembri= Rhus rosmarinifolia Vahl.
Gerberbaum= Rhus Coriaria L.
Gummi Copal= Rhus Copallina L.
Hedera surrecta triphylla, medio folio querciformi?= Rhus quercifolia (Michx.) Steud.
Hedera lactescens nunc recta nunc scandens trifoliata, folio querciformi ?= Rhus quercifolia (Michx.) Steud.
Hedera trifoliae Canadense affinis Planta, peregrina, arbor venenata, Quorundam ?= Rhus quercifolia (Michx.) Steud.
Hedera trifoliae Canadensi affinis, surrecta, Arbor tinctoria, Virginia multis ?= Rhus quercifolia (Michx.) Steud.
Hedera trifoliae Canadensi affinis planta: Arbor venenata quorundam= Rhus quercifolia (Michx.) Steud.
Hedera trifoliae, racemosa Canadensis ?= Rhus quercifolia (Michx.) Steud.

Hedera trifolia Virginiensis= Rhus quercifolia (Michx.) Steud.
Lentisci Pecuani similia Molle dicta= Rhus Copallina L.
Lentiscus humilis trifolia Africana= Rhus lucida L.
Lentiscus Africana trifolia humilis= Rhus lucida L.
Lentiscus Africana triphyllos Quorundum= Rhus lucida L.
Metopium foliis subrotundo pinnato-quinatis, racemis alaribus= Metopium Brownei (Jacq.) Urb.
Metopium Brownei (Jacq.) Urb., see page 317.
Molle= Rhus Copallina L.
Molle s. Lentisco Peruviana= Rhus Copallina L.
Molli Petri Ciecae= Rhus Copallina L.
Myrica trifoliata foliis ternatis dentatis= Rhus aromatica Marsh.
Negunda foemina= Rhus lucida L.
Negunda foemina Acostae ex sententia= Rhus lucida L.
Negunda mare Acostae habet, minus recte= Rhus angustifolia L.
Negunda mas= Rhus tomentosa L.
Rem-Nosi= Rhus tomentosa L.
Rhamnus pentaphyllus= Rhus pentaphylla Desf.
Rhamnus siculus= Rhus pentaphylla.
de Rhoë sive Rhucoriaria= Rhus Coriaria L.
Rhois obsoniorum similis Americana non serrata, rachi media alata= Rhus Copallina L.
Rhus= Rhus Coriaria L.
Rhus africana Mill., see page 314.
Rhus Africanum= Rhus africana Mill.
Rhus (Africanum) foliis ternatis, foliolis ovatis nervosis, marginibus saepius dentatis utrinque viridibus= Rhus africana Mill.
Rhus Africanum, longo et angusto folio subtus incano, non crenato= Rhus rosmarinifolia Vahl.
Rhus Africanum strictissimus foliis trifoliatum= Rhus rosmarinifolia Vahl.
Rhus Africanum trifoliatum, foliis longissimus=?
Rhus Africanum trifoliatum, foliis oblongis ex angusto principio in apicum disenentibus =?
Rhus Africanum trifoliatum, foliis serratis= Rhus angustifolia L.
Rhus Africanum trifoliatum latis Rosmarini foliis, subtus argenteis= Rhus rosmarinifolia Vahl.
Rhus Africanum trifoliatum majus, foliis acutioribus argutius denticulatis glabris subtus argenteis=?
Rhus Africanum trifoliatum, majus, foliis acutioribus incisis supra viridibus glabris infra argenteis glabris=?
Rhus Africanum trifoliatum majus foliis obtusis et incisis, hirsutie pubescentibus= Rhus laevigata L.
Rhus Africanum trifoliatum majus foliis subtus argenteis acutis et margine incisis= Rhus angustifolia L.
Rhus Africanum trifoliatum majus foliis subtus argenteis, acutis, margine incisis= Rhus angustifolia L.
Rhus Africanum trifoliatum majus folio rotundo glabro= Rhus lucida L.
Rhus Africanum trifoliatum majus, glabrum, splendente utrinque folio, subrotundo, medio quandoque crenato= Rhus africana Mill.
Rhus Africanum trifoliatum majus, spendente folio rotundo, integro, priori omnibus partibus est=?
Rhus Africanum trifoliatum minus, glabrum, splendente folio rotundo, integro= Rhus lucida L.
Rhus Africanum trifoliatum minus, glabrum, splendente folio subrotundo, integro= Rhus lucida L.
Rhus Africanum trifoliatum minus, glabrum, splendente folio subrotundo, integro forte Lentiscus Africanus triphyllos quorundam=Rhus lucida L.
Rhus Africanum trifoliatum angustissimo folio, subtus incano, seu Angi casti lobis=?
Rhus Africanum trifoliatum foliis brevioribus, nervosis, superne glabris et splendentibus, subtus incanus=?

Rhus Africanum trifoliatum majus folio subrotundo integro, molle et incano= Rhus laevigata L.
Rhus Africanum trifolium minus glabrum, splendente folio subrotundo integro, forte Lentiscus Africanus triphyllos quorundum= Rhus lucida L.
Rhus Allobrogum= Cotinus Coggygria Scop.
Rhus Americanum, rachi, cui adnuscuntur folio, rubra, folio lata utrinque glabro non serrata, pistachiae simili= Rhus Copallina L.
Rhus Americanum, rachi (cui adnuscuntur folia) rubra, folio lata utrinque glabro non serrata, pistachiae simili= Rhus Copallina L.
Rhus Americanum rachi folia adnascuntur, rubra foliis praecedenti angustioribus= Rhus Copallina L.
Rhus Americanum panicula sparsa herbacea= Rhus glabra L.
Rhus Americanum panicula sparsa herbacea, ramis patula glabris= Rhus glabra L.
Rhus angustifolia L., see page 311.
Rhus angustifolium= Rhus angustifolia L.
Rhus angustifolium= Rhus glabra L.
Rhus arboreum trifoliatum latifolium= Rhus lucida L.
Rhus argentea= Rhus angustifolia L.
Rhus argenteum= Rhus angustifolia L.
Rhus (Argenteum) foliis ternatis, foliolis petiolatis lineari-lanceolatis integerrimis subtus tomentosis= Rhus angustifolia L.
Rhus aromaticum= Rhus aromatica Ait.
Rhus aromatica Ait., see page 307.
Rhus baccis rubentibus, foliis serratis= Rhus glabra L.
Rhus canadense= Rhus glabra L.
Rhus canadense= Rhus aromatica Ait.
Rhus (Canadense) foliis pinnatis, obsolete serratis, lanceolatis utrinque glabris, panicula composita= Rhus glabra L.
Rhus canadense, folio longiori, utrinque glabra= Rhus glabra L.
Rhus canadensis= Rhus aromatica Ait.
Rhus Capensis foliata trifidis latioribus serratis subtus albidus= ?
Rhus Capensis trifoliata angustifolia subtus alba= ?
Rhus Capensis trifoliata laevis major= ?
Rhus Capensis trifoliata laevis minor= ?
Rhus Capensis trifoliata villosa integra= Rhus laevigata L.
Rhus Capensis trifoliata villosa serrata= ?
Rhus Carolinianum= Rhus glabra L.
Rhus (Carolinianum) foliis pinnatis serratis lanceolatis subtus incisis, panicula compacta= Rhus glabra L.
Rhus Carolinianum, panicula speciosa coccinea= Rhus glabra L.
Rhus caule pubescente, foliis ternatis, foliolis sessilibus ovatis integris pubescenti-villosis= Rhus laevigata L.
Rhus chinense= Rhus javanica L.
Rhus (Chinense) foliis pinnatis, foliolis ovatis, obtuse serratis, petiolo membranaceo villoso= Rhus javanica L.
Rhus Chusan Sorbi folio vix serrato, rachi alata= ?
Rhus Copallina L., see page 305.
Rhus Copallinum= Rhus Copallina L.
Rhus (Copallinum) foliis pinnatis integerrimis, petiolo membranaceo articulato= Rhus Copallina L.
Rhus Coriaria L., see page 302.
Rhus (Coriaria) foliis pinnata; petiolus inter foliola ultima subalatus; foliola ovalia obtusiuscule serrata, supra scabra subtus villosa= Rhus Coriaria L.
Rhus (Coriaria) foliis pinnatis obtusiuscule serratis, ovalibus subtus villosis= Rhus Coriaria L.
Rhus Cotinus= Cotinus Coggygria Scop.
Rhus (Cotinus) foliis simplicibus obovatis= Cotinus Coggygria Scop.
Rhus culinaria sive obsoniorum; Rhus coriaria= Rhus Coriaria L.
Rhus culinarij= Rhus Coriaria L.

Rhus culinarium= Rhus Coriaria L.
Rhus culinarius obsoniorum= Rhus Coriaria L.
Rhus cuneifolia L. fil., see page 314.
Rhus cuneifolium= Rhus cuneifolia L. fil.
Rhus dentata Thunb., see page 314.
Rhus dentatum= Rhus dentata Thunb.
Rhus elatior foliis cum impari pinnatis, petiolis membranaceis articulatis foliolis minoribus nonnunquam non exacte oppositis; racemis atrorubentibus= Rhus Copallina L.
Rhus elatior foliis impari-pinnatis, petiolis membranaceis articulatis= Rhus Copallina L.
Rhus elegans= Rhus glabra L.
Rhus Erythros= Rhus Coriaria L.
Rhus Floridana minor. Clematis Conterrheni foliis, subtus lanatus= ?
Rhus foliis lanceolatis argute serratis; subtus tomentosis= Rhus typhina L.
Rhus foliis lineari-lanceolatis integerrimus glabris, basi attenuatis: intermedio subpetiolato= Rhus lancea L. fil.
Rhus foliis pinnatis, argute serratis lanceolatis subtus tomentosis=Rhus typhina L.
Rhus foliis pinnatis, foliolis elliptices obtuse dentatis, subtus villosus= Rhus Coriaria L.
Rhus foliis pinnatis, foliolis lanceolatis acuminatis argute serratis subtus pilosiusculis= Rhus typhina L.
Rhus foliis pinnatis, foliolis ovatis, obtuse serratis, petiolo membranaceo villoso= Rhus javanica L.
Rhus foliis pinnatis integerrimis= Rhus Vernix L.
Rhus foliis pinnatis integerrimis annuis opacis, petiolo integro aequali= Rhus Vernix L.
Rhus foliis pinnatis integerrimis, cordato-oblongis acuminatis, ramis petiolisque villosissimis= Rhus typhina L.
Rhus foliis pinnatis integerrimis perennantibus lucidus: petiolo integro aequali= Rhus succedanea L.
Rhus foliis pinnatis integerrimis petiolo integris= Rhus Vernix L.
Rhus foliis pinnatis integerrimis (petiolo integro)= Rhus Vernix L.
Rhus foliis pinnatis integerrimis petiolo membranaceo articulato= Rhus Copallina L.
Rhus foliis pinnatis lanceolatis, argute serratis subtus tomentosus= Rhus typhina L.
Rhus foliis pinnatis lanceolatis serratis, utrinque nudis, floribus dioicis=Rhus glabra L.
Rhus foliis pinnatis lanceolatis serratis, utrinque nudis, floribus hermaphroditis= Rhus glabra L.
Rhus foliis pinnatis obsolete serratis, lanceolatis, utrinque glabris, panicula composite= Rhus glabra L.
Rhus foliis pinnatis obtusiuscule serratis ovalibus subtus villosis= Rhus Coriaria L.
Rhus foliis pinnatis obtusiuscule serratis, ovato-lanceolatis subtus villosis= Rhus Coriaria L.
Rhus foliis pinnatis, ovatis acuminatis serratis subtus tomentosis= Rhus javanica L.
Rhus foliis pinnatis, pedunculo communi membranaceo articulato= Rhus Copallina L.
Rhus foliis pinnatis, petiolo membranaceo articulato= Rhus Copallina L.
Rhus foliis pinnatis quinatis integerrimis ovatis glabris= Metopium Brownei (Jacq.) Urb.
Rhus foliis pinnatis quinatis integerrimis subrotundis glabris= Metopium Brownei (Jacq.) Urb.
Rhus foliis pinnatis serratis= Rhus Coriaria L.
Rhus foliis pinnatis serratis= Rhus Copallina L.
Rhus foliis pinnatis serratis lanceolatis, subtus incanis, panicula compacta= Rhus typhina L.
Rhus foliis pinnatis serratis lanceolatis, utrinque glabris= Rhus glabris L.
Rhus foliis pinnatis serratis lanceolatis, utrinque nudis= Rhus glabris L.
Rhus foliis pinnatis serratis, petiolis extimis internodiis, membranaceis= Rhus javanica L.
Rhus foliis pinnatis serratis (subtus villosis)= Rhus Coriaria L.
Rhus foliis simplicibus obovatis= Cotinus Coggygria Scop.
Rhus foliis ternatis, foliolis cuneiformibus septemdentatis glabris= Rhus cuneifolium L. fil.
Rhus foliis ternatis, foliolis cuneiformibus, sessilibus= Rhus lucida L.

Rhus foliis ternatis, foliolis inciso-pnnatifidus subtus tomentosis= Rhus incisa L. fil.
Rhus foliis ternatis, foliolis lanceolato-subulatis elongatis utrinque glaberrimis= Rhus lancea L. fil.
Rhus foliis ternatis, foliolis lanceolatis integris glabris= Rhus lancea L. fil.
Rhus foliis ternatis, foliolis lineari-lanceolatis integerrimis glabris basi attenuatis, intermedio subpetiolato= Rhus lancea L.
Rhus foliis ternatis, foliolis lineari-lanceolatis petiolatis integerrimis= Rhus angustifolia L.
Rhus foliis ternatis, foliolis obovatis integerrimis sessilibus utrinque pilosis= Rhus laevigata L.
Rhus foliis ternatis, foliolis obovatis mucronatis glabris, ramis villosis= Rhus pubescens Thunb.
Rhus foliis ternatis, foliolis obovatis mucronato-dentatis glabris, caule scabro= Rhus dentata Thunb.
Rhus foliis ternatis, foliolis obovatis retusis glabris= Rhus lucida L.
Rhus foliis ternatis, foliolis obverse cordatis sessilibus= Rhus lucida L.
Rhus foliis ternatis, foliolis ovatis acuminatis integris glabris= Rhus laevigata L.
Rhus foliis ternatis, foliolis ovatis integris villosis= Rhus laevigata L.
Rhus foliis ternatis, foliolis ovatis nervosis, marginibus, saepius dentatis, utrinque viridibus= Rhus africana Mill.
Rhus foliis ternatis, foliolis ovatis obtusis sinuatis subtus villosis=Rhus sinuata Thunb.
Rhus foliis ternatis, foliolis ovatis subtus tomentosis= Rhus laevigata L.
Rhus foliis ternatis, foliolis ovatis utrinque acutis dentatis petiolatis= Rhus tomentosa L.
Rhus foliis ternatis, foliolis ovatis utrinque dentatis: lateralibus petiolatis= Rhus tomentosa L.
Rhus foliis ternatis, foliolis ovatis utrinque acutis dentatis lateralibus petiolatis= Rhus tomentosa L.
Rhus foliis ternatis; petiolatis angulatis pubescentibus (pr.p.)= Rhus Toxicodendron L., et Rhus quercifolia (Michx.) Steud.
Rhus foliis ternatis foliolis petiolatis angulatis pubescentibus, caule radicante= Rhus quercifolia (Michx.) Steud.
Rhus foliis ternatis foliolis petiolatis lineari-lanceolatis integerrimis subtus tomentosis= Rhus angustifolia L.
Rhus foliis ternatis: foliolis petiolatis ovatis acutis dentatis= Rhus tomentosa L.
Rhus foliis ternatis, foliolis petiolatis ovatis acutis integris= Rhus Toxicodendron L. et Rhus quercifolia (Michx.) Steud.
Rhus foliis ternatis, foliolis petiolatis ovatis acutis pubescentibus: integris sinuatisque= Rhus quercifolia (Michx.) Steud.
Rhus foliis ternatis, foliolis petiolatis ovatis acutis pubescentibus, nunc integris, nunc sinuatis= Rhus Toxicodendron L.
Rhus foliis ternatis, foliolis petiolatis ovatis nudis integerrimis, caule radicante= Rhus Toxicodendron L.
Rhus foliis ternatis, foliolis sessilibus cuneiformibus glaberrimis septemdentatis, dentibus mucronatis= Rhus cuneifolium L. fil.
Rhus foliis ternatis, foliolis sessilibus cuneiformibus inciso-pinnatifidis subtus tomentosis venosis, calycibus tomentosis= Rhus incisa L. fil.
Rhus foliis ternatis, foliolis sessilibus cuneiformibus laevibus= Rhus lucida L.
Rhus foliis ternatis, foliolis sessilibus cuneiformi-rhombeis, inciso-serratis glabris= Rhus aromatica Ait.
Rhus foliis ternatis, foliolis sessilibus lanceolatis laevibus= Rhus laevigata L.
Rhus foliis ternatis, foliolis sessilibus linearibus revolutis subtus ferrugineis= Rhus rosmarinifolia Vahl.
Rhus foliis ternatis, foliolis sessilibus ovato-rhombeis, inciso-serratis glabris= Rhus aromatica Ait.
Rhus foliis ternatis, foliolis sessilibus ovato-rhombeis, inciso serratis pilosiusculis= Rhus aromatica Ait.
Rhus foliis ternatis, foliolis subpetiolatis, rhombeis angulatis, subtus tomentosis= Rhus tomentosa L.
Rhus foliis ternatis, linearibus integris rigidis glabris= Rhus rigidum Mill.

Rhus foliis ternatis, lineari-lanceolatis integerrimis sessilibus utrinque viridibus= ?
Rhus folio pinnata, petiolus inter foliola ultima subalatus; foliola ovalia obtusiuscula serrata, supra scabra subtus villosa= Rhus Coriaria L.
Rhus folio Ulmi= Rhus Coriaria L.
Rhus fruticosum, foliis trifidis linearibus, acuminatis= Rhus rosmarinifolia Vahl.
Rhus glabra L., see page 303.
Rhus glabrum= Rhus glabra L.
Rhus glabrum canadense= Rhus glabra L.
Rhus glabrum carolinense= Rhus glabra L.
Rhus (Glabrum) foliis pinnatis serratis lanceolatis utrinque glabris= Rhus glabra L.
Rhus glabrum panicula speciosa coccinea= Rhus glabra L.
Rhus incana= Rhus laevigata L.
Rhus incanum= Rhus laevigata L.
Rhus (Incanum) foliis ternatis, foliolis ovatis subtus tomentosis= Rhus laevigata L.
Rhus incisa L. fil., see page 313.
Rhus incisum= Rhus incisa L. fil.
Rhus javanica L., see page 305.
Rhus javanicum= Rhus javanica L.
Rhus laevigata L., see page 315.
Rhus laevigata= Rhus Legati.
Rhus laevigatum= Rhus laevigata L.
Rhus lancea= L. fil., see page 315.
Rhus lanceum= Rhus lancea L. fil.
Rhus (Lanceum) foliis ternatis, foliolis lanceolati integris glabris= Rhus lancea L. fil.
Rhus (Lanceum) foliis ternatis, foliolis lanceolato-subulatus elongatus utrinque glaberrimis= Rhus lancea L. fil.
Rhus late scandens, foliis ternatis ?= Rhus Toxicodendron L.
Rhus Legati Schonl., see page 316.
Rhus lucida L., see page 313.
Rhus lucidum= Rhus lucida L.
Rhus (Lucidum) foliis ternatis, foliolis sessilibus cuneiformibus laevibus= Rhus lucida L.
Rhus MacOwani= ? Rhus pubescens Thunb.
Rhus marinus= Rhus Coriaria L.
Rhus Metopium= Metopium Brownei (Jacq.) Urb.
Rhus mucronata= Rhus laevigata L.
Rhus obsoniorum= Rhus Coriaria L.
Rhus obsoniorum et coriariorum= Rhus Coriaria L.
Rhus Obsoniorum similis Americana, Gummi candidum sundens non serrata, foliorum Rachi medio alata= Rhus Copallina L.
Rhus Obsoniorum similis Peruviana, serratis Fraxini pinnatis foliis, summa singulari pinna alas claudenta longius exporrecta ?= Rhus Copallina L.
Rhus orientalis= Rhus Coriaria L.
Rhus pentaphylla Desfont., see page 315.
Rhus pentaphyllum= Rhus pentaphylla Desfont.
Rhus pubescens Thunb., see page 316.
Rhus quercifolia (Michx.) Steud., see page 308.
Rhus quinquefolia Sinarum lactescens, rachi medio alata, foliis molli hirsutie pubescentibus= Rhus javanica L.
Rhus racemis plumosis, foliis ovatis= Cotinus Coggygria Scop.
Rhus radicans= Rhus Toxicodendron L.
Rhus radicans lucidum= Rhus Toxicodendron L.
Rhus radicans opacum= Rhus Toxicodendron L.
Rhus ramis ex stipite pullulantibus glabris= Rhus glabra L.
Rhus, Rhus veterum; coriaria, obsoniorum, et Sumac= Rhus Coriaria L.
Rhus rigida Mill., see page 314.
Rhus rigidum= Rhus rigida Mill.
Rhus (Rigidum) foliis ternatis linearibus integris rigidis glabris= Rhus rigida Mill.
Rhus rosmarinifolium Vahl., see page 311.

Rhus rubra= Rhus Coriaria L.
Rhus semialatum= Rhus javanica L.
Rhus sive Sumach= Rhus Coriaria L.
Rhus siculus pentaphyllus= Rhus pentaphylla Desfont.
Rhus sinarum lactescens, costa foliorum alata= Rhus javanica L.
Rhus sinuata Thunb., see page 314.
Rhus sinuatum= Rhus sinuata Thunb.
Rhus spinis terminalibus, foliolis ternatis quinatisque= Rhus pentaphylla Desfont.
Rhus spinis terminalibus, foliolis solitariis quinatisque=Rhus pentaphylla Desfont.
Rhus sive Sumach Africanum trifolium, hirsutum et crenatum= Rhus tomentosa L.
Rhus staturae minoribus, foliis racemisque minoribus ?= Rhus glabra L.
Rhus suaveolens= Rhus aromatica Ait.
Rhus succedanea L., see page 311.
Rhus succedaneum= Rhus succedanea L.
Rhus Sumach= Rhus Coriaria L.
Rhus Syriacum= Rhus Coriaria L.
Rhus tenuifolia Virginiana humilis= Rhus glabra L.
Rhus tenuifolia Virginiana humilis: Rhus, angustifolium= Rhus glabra L
Rhus tenuifolia Virginiana humilis; Rhus Virginianum ramis ex stipite pullulantibus glabris= Rhus glabra L.
Rhus tomentosa L., see page 312.
Rhus tomentosum= Rhus tomentosa L.
Rhus (Tomentosum) foliis ternatis, foliolis subpetiolatis, rhombeis angulatis, subtus tomentosis= Rhus tomentosa L.
Rhus Toxicodendron (pr.p.)= Rhus Toxicodendron L., et Rhus quercifolia (Michx.) Steud.
Rhus Toxicodendron L., see page 307.
Rhus Toxicodendrum (pr.p.)= Rhus Toxicodendron L., et Rhus quercifolia (Michx.) Steud.
Rhus-Toxicodendron radicans= Rhus Toxicodendron L.
Rhus-Toxicodendron toxicodendrum= Rhus quercifolia (Michx.) Steud.
Rhus-Toxicodendron Vernix= Rhus Vernix L.
Rhus trifoliatum Brasilianum, foliis glabris= ?
Rhus typhina L., see page 304.
Rhus typhinum= Rhus typhina L.
Rhus (Typhinum) foliis pinnatis lanceolatis, argute serratis subtus tomentosis= Rhus typhina L.
Rhus vernicifera DC., see page 310.
Rhus Vernix L., see page 310.
Rhus villosa= Rhus laevigata L.
Rhus villosum= Rhus laevigata L.
Rhus viminale= Rhus lancea L. fil.
Rhus viminalis= Rhus lancea L. fil.
Rhus Virginiana= Rhus typhina L.
Rhus Virginianum= Rhus typhina L.
Rhus Virginianum humile= Rhus glabra L.
Rhus Virginianum Lentisci foliis= Rhus Copallina L.
Rhus Virginianum Lentisci foliis Banisteri= Rhus Copallina L.
Rhus Virginianum, ramis ex stipiti pullulantibus glabris= Rhus glabra L.
Rhus Virginianum, panicula sparsa, ramis patulis glabris= Rhus glabra L.
Rhus Virginicum= Rhus glabra L.
Rhus Virginicum panicula sparsa, ramis patulis glabris= Rhus glabra L.
Rhus Virginicum Lentisci foliis, Banisteri= Rhus Copallina L.
Rosmarini foliis, ternis, angustis fructescens planta Africana, floribus spicatis, pentapetalis, minimus, cujus et minor ibi notatur varietas= Rhus rosmarinifolia Vahl.
Ῥοῦς= Rhus Coriaria L.
Schmaltzia crenata (Mill.) Greene= Rhus aromatica Ait.
Scotanum vulgo= Cotinus Coggygria Scop.
Sitz s. Sitz-dsiu= Rhus vernicifera DC.

Sitz vel Sitz-diu= Rhus vernicifera DC.

Sitz, vel Sitz dsju, i.e. Sitz planta, vulgo Urus seu Urus no ki= Rhus vernicifera DC.

Sumach= Rhus Coriaria L.

Sumach angustifolium= Rhus glabra L.

Sumach Arabum= Rhus Coriaria L.

Sumach sive Rhus obsoniorum et coriariorum= Rhus Coriaria L.

Sumach s. Rhus Virginiana= Rhus typhina L.

Terebinthus Americana, pistacia fructu non eduli ?= Metopium Brownei (Jacq.) Urb.

Terebinthus Americana polyphylla= Metopium Brownei (Jacq.) Urb.

Terebinthus Brovvnii= Metopium Brownei (Jacq.) Urb.

Terebinthus maxima= Metopium Brownei (Jacq.) Urb.

Terebinthus maxima pinnis paucioribus, majoribus atque rotundioribus, fructu racemoso sparso= Metopium Brownei (Jacq.) Urb.

Therebinthus American polyphylla= Metopium Brownei (Jacq.) Urb.

Toxicodendron altissimum= Rhus succedanea L.

Toxicodendron (Altissimum) foliis pinnatis sessilibus, lobis acuminatis= Rhus succedanea L.

Toxicodendron amplexicaule, foliis minoribus glabris= Rhus Toxicodendron L.

Toxicodendron Carolinianum foliis pinnatis, floribus minimis herbaceis=Rhus Vernix L.

Toxicodendron crenatum= Rhus aromatica Ait.

Toxicodendron (Crenatum) foliis ternatis, foliolis ovatis crenato-dentatis glabris= Rhus aromatica Ait.

Toxicodendron erectum procerum, foliis alatis, fructu rhomboide= Rhus Vernix L.

Toxicodendron foliis alatis, fructu rhomboide= Rhus Vernix L.

Toxicodendron foliis saepius ternatis, foliolis oblongo-ovato rugosis serratis, caule radicante= Rhus quercifolia (Michx.) Steud.

Toxicodendron foliis pinnatis, foliolis ovato-lanceolatis integerrimis sessilibus, lobis acuminatis= Rhus succedanea L.

Toxicodendron foliis ternatis, foliolis obcordatis, glabris, integerrimis, caule radicante= Rhus Toxicodendron L.

Toxicodendron foliis ternatis, foliolis ovatis crenato-dentatis glabris= Rhus canadensis Marsh.

Toxicodendron foliis ternatis, foliolis ovatis inciso-angulatis pubescentibus= Rhus quercifolia (Michx.) Steud.

Toxicodendron foliis ternatis, foliolis ovatis inciso-sinuatis glabris, caule volubile radicante= Rhus Toxicodendron L.

Toxicodendron foliis ternatis, foliolis ovato-lanceolatis glabris caule erecto fruticoso= Rhus Toxicodendron L.

Toxicodendron Glabrum= Rhus Toxicodendron L.

Toxicodendron (Glabrum) foliis ternatis, foliolis ovato-lanceolatis glabris caule erecto fruticosa= Rhus Toxicodendron L.

Toxicodendron minus erectum capsularum tegumentum pilosis= Rhus quercifolia (Michx.) Steud.

Toxicodendron pinnatis= Rhus Vernix L.

Toxicodendron (Pinnatis) foliis pinnatis foliolis ovato-lanceolatis integerrimis= Rhus Vernix L.

Toxicodendron pinnatum= Rhus Vernix L.

Toxicodendron (Pinnatum) foliis pinnatis foliolis ovatolanceolatis integerrimis= Rhus Vernix L.

Toxicodendron pubescens= Rhus quercifolia (Michx.) Steud.

Toxicodendron (Pubescens) foliis ternatis, foliolis ovatis inciso-angulatis= Rhus quercifolia (Michx.) Steud.

Toxicodendron quercifolia (Michx.) Dippel= Rhus quercifolia (Michx.) Steud.

Toxicodendron radicans (L.) Kuntze= Rhus Toxicodendron L.

Toxicodendron rectum, foliis minoribus glabris= Rhus Toxicodendron L.

Toxicodendron scandens, foliis in eodem pediculo ternis pendulis reflexis, cortice inciso, serculis foliisve divulsis= Rhus Toxcodendron L.

Toxicodendron serratum= Rhus quercifolia (Michx.) Steud.

Toxicodendron (Serratum) foliis saepius ternatis, foliolis oblongo-ovalo rugosi serratis, caule radicante= Rhus quercifolia (Michx.) Steud.
Toxicodendron succedanea (L.) Kuntze= Rhus succedanea L.
Toxicodendron triphyllon, glabrum= Rhus Toxicodendron L.
Toxicodendron triphyllum, folio sinuate pubescente= Rhus quercifolia (Michx.) Steud.
Toxicodendron triphyllum, glabrum= Rhus Toxicodendron L.
Toxicodendron vernicifera (DC.) Barkley & Barkley= Rhus vernicifera DC.
Toxicodendron Vernix (L.) Kuntze= Rhus Vernix L.
Toxicodendron volubis= Rhus Toxicodendron L.
Toxicodendron (Volubis) foliis ternatis, foliolis ovatis inciso-sinuatis glabris, caule volubili radicante= Rhus Toxcodendron L.
Toxicodendron vulgare= Rhus Toxicodendron L.
Toxicodendron (Vulgare) foliis ternatis, foliolis obcordatis glabris integerrimis caule radicante= Rhus Toxicodendron L.
Toxicodendron vulgare latifolium= Rhus Toxicodendron L.
Toxicodendrum glabrum= Rhus Toxicodendron L.
Tsumakh= Rhus Coriaria L.
Venice Sumack= Cotinus Coggygria Scop.
Virginian Sumack= Rhus typhina L.
Virginische Gerberbaum= Rhus typhina L.
Vitex trifolia Indica serrata= Rhus angustifolia L.
Vitex trifolia minor Indica rotundifolia= Rhus lucida L.
Vitex trifolia minor Indica serrata= Rhus tomentosa L.
Vitis Canadensis= Rhus quercifolia (Michx.) Steud.
Vitis sylvestris trifolia= Rhus quercifolia (Michx.) Steud.
Vitis sylvestris trifolia Canadensis= Rhus quercifolia (Michx.) Steud.
'Wig-tree'= Cotinus Coggygria Scop.
Yztac-Quauxihotl alia Galiopifera= Rhus Copallina L.

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DEPARTMENT OF BOTANY,
MONTANA STATE UNIVERSITY,
MISSOULA, MONTANA.

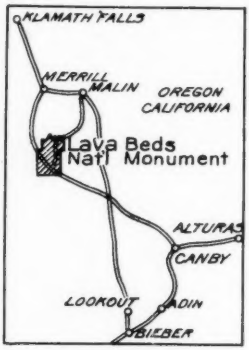
Plants of the Lava Beds National Monument, California

Elmer I. Applegate

The Lava Beds National Monument lies for the most part in northeastern Siskiyou County, California, some 15 miles south of the Oregon-California line. A detached part includes a small area on the nearby Tule Lake Peninsula in northwestern Modoc County. This last was added primarily for the purpose of preserving the Indian writings (Petroglyphs) or pictures found in the cliffs there.

The total area covers approximately 46,000 acres, roughly a rectangular tract 8 by 9 miles in extent. In elevation it ranges from about 4,000 feet on the north, along the shore of Tule Lake, up to about 5,700 feet in the southwest corner, where, outside the monument, the ascent continues more abruptly for a distance of about 6 miles, culminating in the crater-like escarpment surrounding Medicine Lake, the highest points of which are around 8,000 feet above sea level.

Geologically the entire area (Fig. 1) is the result of comparatively recent volcanic activity, covering the surface with successive lava flows, coming largely from the Medicine Lake region just mentioned. The ends of the flows are often marked by walls of varying heights which break the more even ascent from north to south; while long sinuous interrupted depressions with an opposite trend indicate the partially broken-down roofs of lava tubes along the line of flow. The undisturbed portions, remaining as bridges, often leave exposed ends of galleries which are known as caves. Most of the area is covered by a varying depth of pumice sand and gravel, providing the most important soil element.



Distributed over the northwest quarter, relieving the monotony of the more even topography of the surrounding plain, are the so-called "buttes" (Figs. 2 and 3). These consist of about a dozen symmetrical cinder cones, each with its miniature crater. They vary in height from 100 to 500 or more feet above the general level of the plain, and are the result of secondary volcanic action. Juniper Butte, the southernmost elevation, is a much older formation, being composed mainly of stratified volcanic sand or tuff, the origin of which opens up, in this particular instance, an interesting question for the geologist. Island Butte, near the western boundary, is surrounded by

Fig. 1. General view of the Lava Beds National Monument; cinder cones in the distance.

the most recent local flow of black clinker-like lava known as the Black Lava Flow, similar to the Devil's Homestead, the rugged lava outpouring along Gillem Bluff. Except where there is an accumulation of pumice sand, these areas support comparatively little vegetation.

The annual precipitation is less than in other parts of the Klamath Basin, summer rains are rare and the moisture content of the atmosphere is low. The porosity of the loose soil absorbs the moisture rapidly, and the prevailing spring weather is cool with drying winds, so that before there is sufficient heat to germinate seed and start plant growth, much of the limited moisture has been taken up by the soil or has escaped through evaporation. Thus we have a situation especially unfavorable for short-lived or ephemeral plants. There are no living springs or streams with their characteristic plants. And so we find here plant life largely limited to those forms usually found in the cooler arid or semi-arid plains region. Nevertheless the flora in general is not lacking in interest. A considerable number of the plants are especially attractive and noteworthy. Many colorful spots relieve the drabness of the landscape, and are all the more noticeable because of their surroundings. The most interesting centers of plant life are found on the precipitous slopes of the cinder cones. Of these, Caldwell Butte is the most outstanding. On its slopes, within its well defined crater, and in the immediate vicinity there are a greater number of species, and more of peculiar interest and beauty, than in any other section of the whole monument area.

In an account of the plants of a region, the subject of their origin and distribution is of interest. In this connection it might be well to define some of the terms employed in telling the story. Distribution of life over the surface of the earth is very largely influenced by temperature. Within any given area this is mainly a question of altitude, in a consideration of which it is necessary to keep in mind various minor local influences such as slope expos-

ure, soil and moisture conditions, etc. As we ascend an even mountain slope the change in the character of the vegetation is plainly evident. In the foothills and lower levels are found the forms adapted to a higher temperature, those requiring a moderate amount of heat reach their maximum development at middle altitudes, while such as are inured to cooler conditions occupy the upper reaches and so on (if the mountain is high enough) up to the limit of plant life. Since each species fits into its own particular place in the temperature scale, we find the plants of the mountain slopes arranged in more or less definite belts. These are known as Life Zones. The laws governing them were worked out by C. Hart Merriam, first Chief of the United States Biological Survey. While in a general way the line between any two belts is often well defined, frequently there is overlapping, and, apparently, interruption because of local factors, easily interpreted if understood.

As to origin, there are two primary groups: Those migrating from the north, known as Boreal, and those coming from the south, designated as Austral. These are in turn subdivided into lesser groups. In the general trends of distribution the species are interrupted and diverted by mountain ranges, river gaps, bodies of water, etc. Covering the lower and more arid plains east of the Cascade Mountains is the Upper Sonoran Zone, the name derived from Sonora, Mexico, a region of desert conditions. Much of the lower part of the Klamath Basin, of whici the monument is a part, is included in this zone. Dominant plants of this group include the sage- and rabbitbrushes, desert gooseberry, desert sage and their associates. These run well up into the monument area mingling with and gradually being superseded by plants of the next zone above, the Transition, so designated because it covers an intermediate and overlapping position between the northern (Boreal) and the southern (Austral) plants. This belt is typified by the ponderosa or

Fig. 2. Sconchin Butte: western juniper in foreground and desert mahogany in the center.

Fig. 3. Hippo Butte showing strip of yellow pines on northerly slope; western white pine on right foreground; western juniper on left.

yellow pine. Other characteristic plants of the Transition Zone in the monument area are incense cedar, snowbrush, squaw-carpet, manzanita and Scouler willow, dominant only in the southwest section and on the northeasterly slopes of some of the cinder cones. The next zone above is found in the Medicine Lake Mountains just to the south. Passing through the ponderosa pine forest (Transition), we gradually find ourselves in a region dominated by lodgepole pine and western white pine and their characteristic associates, typical of the Canadian, a flora corresponding in general to that of the plains region of southern Canada. Well up in this belt we encounter the Shasta fir which leads us into the next Life Zone above, the Hudsonian, which extends to the Medicine Lake rim where the forest is made up largely of mountain hemlock and white-bark pine. The plants here most resemble those found in the region along the southern shore of Hudson Bay, hence the name. On higher mountains, such as Mt. Shasta to the west, there is another upper Life Zone, the Arctic-Alpine, which is the belt above timberline, the temperature conditions being similar to those of the plains regions within the Arctic circle. In this connection, it will be noted that as we go northward there is a lowering of the temperature corresponding to the change encountered in the ascent of a mountain, only the distance is much greater, 300 miles being the approximate equivalent of 1,000 feet of mountain elevation.

Because of its position, its unique geological history and complicated and greatly diversified topography, the region embraced in southwestern Oregon and northwestern California presents unusual features of interest in plant distribution. The center of this region is the Siskiyou Mountains with their connection with the younger Cascade Mountains. The Siskiyous, because of their great age, have become of especial importance and interest as a distribut-

ing center. A considerable proportion of the species are peculiar to it, some of which doubtless developed there, while a lesser number are perhaps remnants of older types of former wider range. On the other hand, subsequent to the emergence of the surrounding land areas, complicated interchange of species has occurred. Thus we have here all these various elements combined into what might be termed a plant melting pot. These in turn are diverted and redistributed along zonal lines by cross-connecting mountain ranges, river gaps, and so on, acting as plant highways. In common with the rest of the region, the Klamath Basin shares in the distributional situation here outlined, and acts as a further collecting and distributing area, exchanging plants with the surrounding regions.

Occupying a position on its western fringe, our flora is largely a reflection of the Great Basin, although the larger element is of northern origin, finding its way into it by a circuitous route. A considerable number of coastal plants, both Californian and northern, which enter the Klamath Basin find lodgment in the more humid section around Klamath Lake. On the other hand, some of the vegetation of the Basin passes through Klamath Gap into the Shasta and Rogue River Valleys.

Of the 10 trees found in the monument, all are cone-bearers with the exception of one poplar and one willow. The first, the common aspen, is rare, being seen only near the south boundary, along the Medicine Lake road in the vicinity of the Heppe Cave road. Here is a grove of perhaps 200 small trees. Yellow willow occurs only on the north boundary along the Tule Lake shoreline. This species is common throughout the Klamath Basin, along streams and lake margins. Western juniper (Fig. 4) is the most widely distributed tree, ranging over the entire area, often forming groves of pure stand and of considerable extent, especially in the cinder cone section, where it is often associated with yellow or ponderosa pine. Next in abundance is the

Fig. 4. Recent black lava-flow; western juniper.

Fig. 5. Knobcone pine on northerly slope of Hippo Butte, looking north over Tule Lake.

ponderosa pine, which is scattered more or less over the southwest quarter, constituting the lower fringe of the extensive forest coming down from the Medicine Lake mountains. Only along the south border, westward from Caldwell Butte, is there anything like a forest stand. Apparently as a result of prolonged drought and the ravages of insects, a large proportion of the trees are dead. Small groves of a fairly good stand occupy the cooler southeasterly slope of some of the larger cinder cones. A grove of incense cedar, numbering about 75 good sized trees, was found on the south border, near and above Caldwell Butte. A few trees occur, scattered among the pines, on Eaglenest Butte and southwestward from Upper Ice Cave. In the latter section white fir is not uncommon. Rarely it is seen on the cooler slopes of the upper cinder cones. Here, also, and along the extreme southern border, small trees of western white pine are of rare occurrence. In the immediate vicinity of Caldwell Ice Caves is an occasional lodgepole pine. There are also a few trees at the north end of Black Lava Flow near Upper Ice Cave. A single tree on Island Butte appears to be the sole representative of the sugar pine, although along the easterly base of Cinder Cone just outside the monument boundary there are several such trees, one of large size. On May 8, 1936, on the easterly slope of Hippo Butte, the writer was surprised to find a single specimen of knobcone pine, a vigorous tree, 25 feet high and a foot in diameter (Fig. 5). It was growing among ponderous pines. It has been reported from the vicinity of Timber Mountain, about 15 miles to the southeast, and southward through the lava fields. Possibly westward there may be other occurrences, connecting up with Mt. Shasta where it is found.

Of the 33 shrubs, bitterbrush is the most common. It is more or less abundant throughout the area, and is dominant northward and eastward from

the cinder cone section, covering perhaps two-thirds of the monument (Fig 6). In parts of the pine forest on the south border it is practically the only shrubby undergrowth. During the flowering season the fragrant yellow blossoms add much to the color of the landscape. Next in abundance comes the common sagebrush, found everywhere, and dominant between the last and the more narrow belt of rabbitbrush along the flat ground on the northern border, making southerly intrusions into the Thomas massacre area, Fleener Chimneys and westward. On and about the upper cinder cones and the caves area in the vicinity of Indian Well, desert mahogany is conspicuous and rather abundant (Fig. 2). Gray-leaf rabbitbrush is common in the low flat land toward the north. Green-leaf rabbitbrush is widely distributed. Another, Bloomer rabbitbrush, with handsome golden-yellow ray-flowers, is comparatively rare except around the easterly base of Caldwell Butte and Bearpaw where it can be seen in flower late in the summer season. White-leaved Tetradymia is widely distributed. Desert fern-bush with its arrowlike stems, fernlike foliage and attractive white flowers, is perhaps the subject of more inquiry than any other shrub. It is most common about the cave entrances and gallery depressions. While the spiny-fruited gooseberry is only sparingly found among the pines of the cinder cones, the desert gooseberry and waxy-currant are common everywhere. Two very strongly aromatic shrubs belonging to the mint family are desert sage and desert pennyroyal. Both have a profusion of purplish or bluish flowers. They are most common in the more rugged broken lava situations. In less abundance, in similar places, is the desert ocean spray with dense clusters of small white flowers. Snowbrush and squaw-carpet belong to the genus *Ceanothus*, the first an erect shrub with varnished leaves and sprays of white flowers, the second with creeping stems and small hollylike leaves and blue flowers. They are always associated with ponderosa pines. A companion to these is the green-leaved manzanita with

Fig. 6. Typical area showing juniper, sage-brush, bitterbrush, etc.

reddish shiny branches. The desert gilia and Douglas phlox are smaller shrubby plants seen on every hand. Bitter-cherry and choke-cherry along with the blue elderberry are not so common. The interior rose is less common, and snowberry only occasional among the pines at Caldwell and Eaglenest Buttes. Service berry is frequently seen from the Stronghold to Mammoth Crater. Shrubby *Eriogonum*, belonging to the same genus as sulphur-flower, grows in large bush-like clumps, has stems with shreddy bark, and bears umbels of tawny-white flowers. It reaches its maximum growth on the slopes of the cinder cones. Bush chinquapin and Scouler willow are just barely within the limits of the monument near the Medicine Lake road.

Up to the present time no systematic collection or comprehensive study has been made of the plants of the Lava Beds region, although for many years the writer has made small collections in the area and thereabouts and recently has made rather extensive investigations around Medicine Lake. In 1896 the writer accompanied Vernon Bailey on a biological reconnaissance southward from Tule Lake through Modoc and Lassen Counties. On this trip the eastern edge of the Lava Beds was skirted and a plant collection made. In 1846 John C. Fremont, while passing over the same ground, picked up a few plants and made some observations on the flora of the region. In connection with the Williamson railroad survey of 1855, Dr. Newberry botanized along the same route. In the early 1890's Mrs. R. M. Austin, a pioneer botanist of northeastern California, collected in this region. For several seasons, beginning in 1893, Milo S. Baker made collections in the Pit River Valley and northward as far as Medicine Lake. These excursions yielded a number of new species, the most noteworthy of which was *Cupressus Bakeri* Jepson (Baker Cypress).

The number of species included in the present account of the plants of the Lava Beds National Monument is approximately 200. These are plants collected by the writer during the seasons of 1935, 1936, and 1937. Doubtless further collecting will add others to the list. The annotated catalogue following is made up of 10 trees, 32 shrubs, approximately 150 herbaceous flowering plants, and 2 ferns. These are included in 39 families.

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KEY TO THE FAMILIES

SPORE PLANTS (PTERIDOPHYTA). Reproduction by spores borne on the surface of the leaf (frond), no embryo being formed. In our area represented by Ferns ---------- *Polypodiaceae.*

SEED PLANTS (SPERMATOPHYTA. Reproduction by seeds, these containing an embryo.

GYMNOSPERMS (Seeds naked). Evergreen trees (in our area); stamens and ovules borne in separate flowers; ovules not in a closed sac (ovary), maturing into naked seeds; fruit a woody cone or a modified cone-like berry ---------- *Pinaceae.*

ANGIOSPERMS (Seeds covered). Ovules in a closed sac (ovary) which becomes the fruit and encloses the seed.

MONOCOTYLEDONS. Leaves parallel-veined; flower-parts usually in 3's or 6's; embryo with 1 cotyledon (seed-leaf).

Plants grass-like.

Flowers in the axils of dry chaffy bracts ---------- *Poaceae.*

Flowers with small greenish or brownish calyx or perianth ---------- *Juncaceae.*

Plants not grass-like.

Flowers with colored calyx or perianth ---------- *Liliaceae.*

DICOTYLEDONS. Leaves net-veined; flower-parts usually in 4's or 5's; embryo with 2 cotyledons (seed-leaves).

APETALOUS SECTION (Without petals). Corolla none; sepals present.

Trees and shrubs.

Pistillate and staminate flowers both in catkins; seeds small, hairy ---------- *Salicaceae.*

Pistillate flowers not in catkins; seeds a nut in a bur ---------- *Castanopsis.*

Flowers not in catkins, small, greenish; plants parasitic on cone-bearing trees ---------- *Loranthaceae.*

Flowers with twisted feathery seed-tails ---------- *Cercocarpus.*

Flowers with 6-parted calyx, and enclosed in an involucre ---------- *Eriogonum.*

Herbs.

Pistil 1, 1-celled.

Stipules sheathing the stem at the nodes; calyx 3- to 6-cleft or divided ---------- *Polygonaceae.*

Stipules not sheathing the stem; tall rough plants with stinging hairs ---------- *Urtica.*

Stipules none.

Flowers minute, greenish, in clusters; calyx 4-5 parted ---------- *Chenopodiaceae.*

Flowers larger, colored, solitary or in heads, surrounded by an involucre; calyx 6-parted ---------- *Eriogonum.*

CHORIPETALOUS SECTION (Petals distinct). Calyx and corolla both present, the latter of distinct petals.

Stamens more than double the number of petals. (Always more than 10.)

Stamens free from the calyx (hypogynous).

Pistils few to many, distinct ---------- *Ranunculaceae.*

Pistil 1, compound; sepals falling as the corolla opens ---------- *Eschscholtzia.*

Stamens borne on the calyx (perigynous).

Leaves with stipules; flowers white, yellow or pinkish ---------- *Rosaceae.*

Leaves without stipules; rough plants with yellow flowers ---------- *Mentzelia.*

Stamens not more than double the number of petals.

Calyx free from the ovary (ovary superior).

Pistils more than 1 and distinct from each other.

Leaves with stipules ---------- *Rosaceae.*
Leaves without stipules ---------- *Saxifragaceae.*
Pistil only 1.
Pistil simple, as shown by the single style, stigma and ovary cell.
Flowers irregular; stamens united; fruit a pod ---------- *Leguminosae.*
Flowers regular; stamens not united; calyx 5-lobed ---------- *Rosaceae.*
Pistil compound.
Ovary 1-celled.
Corolla irregular, the lower petal spurred ---------- *Viola.*
Corolla regular.
Sepals 2 ---------- *Portulacaceae.*
Sepals 4-5; leaves opposite ---------- *Caryophyllaceae.*
Ovary and usually the fruit 2-celled; fruit a pod ---------- *Cruciferae.*
Ovary more than 2-celled.
Ovules and seeds numerous ---------- *Saxifragaceae.*
Ovules and seeds 1-4 in each cell.
Leaves entire ---------- *Linum.*
Leaves divided or compound ---------- *Erodium.*
Calyx adherent to the ovary (ovary inferior).
Flowers in umbels ---------- *Umbelliferae.*
Flowers not in umbels.
Styles 2-5, distinct or united below ---------- *Saxifragaceae.*
Style 1, undivided (but sometimes with slender stigma lobes) ---------- *Onagraceae.*

SYMPETALOUS SECTION (Petals united). Calyx and corolla both present, the latter with petals united at least at the base.
Calyx free from the ovary (ovary superior).
Stamens free from the corolla.
Shrub with crooked reddish branches and urn-shaped flowers ---------- *Arctostaphylos.*
Stamens on the corolla.
Stamens 10; corolla irregular ---------- *Leguminosae.*
Stamens 5 or less.
Corolla regular.
Ovary 2, becoming a pair of pods ---------- *Cycladenia.*
Ovary 1, 4-lobed, forming 4 nutlets ---------- *Boraginaceae.*
Ovary 1, entire.
Style 3-cleft at apex ---------- *Polemoniaceae.*
Style 2 or 1 and 2-cleft ---------- *Hydrophyllaceae.*
Style 1.
Stigma entire ---------- *Solanaceae.*
Stigmas 2 ---------- *Swertia.*
Corolla irregular; stamens with anthers 4 or 2; style 1.
Ovary 4-parted ---------- *Menthaceae.*
Ovary and capsule 2-celled ---------- *Scrophulariaceae.*
Calyx adherent to the ovary (ovary inferior).
Stamens distinct from each other.
Stamens 3; flowers small, irregular ---------- *Plectritis.*
Stamens 4-5.
Leaves in whorls ---------- *Galium.*
Leaves opposite ---------- *Caprifoliaceae.*
Stamens united into a tube around the style; flowers in a head with a calyx-like involucre ---------- *Compositae.*

Annotated Catalogue of Species

1. *Polypodiaceae.* Fern Family.

Stalks (leaf-stems) green ..... 1. *Cystopteris.*
Stalks dark brown, shiny ..... 2. *Gymnogramme.*

1. CYSTOPTERIS Bernh.

1. *Cystopteris fragilis* (L.) Bernh. Brittle Fern. Delicate bright green, about 6 inches high.—Common, growing in dense clumps in rock crevices.

2. GYMNOGRAMME Desv.

1. *Gymnogramme triangularis* Kaulf. Gold Fern. Under surface densely covered with a yellow powder.—Extremely rare on walls of cave entrances.

2. *Pinaceae.* Pine Family.

Leaves needle-like in sheathed bundles ..... 1. *Pinus.*
Leaves linear; cones erect ..... 2. *Abies.*
Leaves scale-like, minute.
  Fruit a small oblong cone ..... 3. *Libocedrus.*
  Fruit a bluish berry ..... 4. *Juniperus.*

1. PINUS L. Pine.

Leaves 5 in a bundle.
  Cones about 8 inches long ..... 1. *P. monticola.*
  Cones about 15 inches long ..... 2. *P. Lambertiana.*
Leaves 3 in a bundle; cones about 4 inches long.
  Cones closed, unsymmetrical ..... 3. *P. attenuata.*
  Cones open, symmetrical ..... 4. P. *ponderosa.*
Leaves 2 in a bundle; cones about 2 inches long ..... 5. *P. contorta.*

1. *Pinus monticola* Dougl. Western White Pine. An occasional tree on cinder cones and near the southwest corner of the mounment area.

2. *Pinus Lambertiana* Dougl. Sugar Pine. Rare in the southwest corner. At least one tree on Island Butte.

3. *Pinus attenuata* Lemmon. Knob-cone Pine. A single small tree on the easterly slope of Hippo Butte, the only one known in the area.

4. *Pinus ponderosa* Dougl. Ponderosa Pine. Yellow Pine. Scattered over the southwest section; forest stands along the south border.

5. *Pinus contorta Murrayana* (Balf.) Engelm. Lodgepole Pine. A few trees southwest of Upper Ice Cave and in the vicinity of Caldwell Ice Caves.

2. ABIES Link. Fir.

1. *Abies concolor* Lindl. White Fir. Rare on the upper cinder cones; more common near the southwest corner.

3. LIBOCEDRUS Endl.

1. *Libocedrus decurrens* Torr. Incense Cedar. Eaglenest Butte; a considerable grove along the south border near and southwest of Caldwell Butte.

4. JUNIPERUS L. Juniper.

1. *Juniperus occidentalis* Hook. Western Juniper. Scattered throughout the region; groves of good stand in the cinder cone area.

3. *Poaceae*. Grass Family.

Spikelets with stems (pedicellate).

Spikelets 1-flowered ---------- Tribe 1. *Agrostideae*.
Spikelets more than 1-flowered.
  Glumes as long as the lowest floret ---- Tribe 2. *Aveneae*.
  Glumes shorter than the first floret ---- Tribe 3. *Festuceae*.
Spikelets stemless (sessile) ---------- Tribe 4. *Hordeae*.

Tribe 1. *Agrostideae*.

Awn very long, twisted and bent ---------- 1. *Stipa*.
Awnless; flower cluster spike-like, dense, cylindric 2. *Phleum*.

Tribe 2. *Aveneae*.

Spikelets 2-flowered; lemmas keeled ---------- 1. *Koeleria*.

Tribe 3. *Festuceae*.

Lemmas with notched apex, awned ---------- 1. *Bromus*.
Lemmas with entire apex, pointed.
  Spikelets awned ---------- 2. *Festuca*.
  Spikelets awnless ---------- 3. Poa.

Tribe 4. *Hordeae*.

Spikelets solitary at each node ---------- 1. *Agropyron*.
Spikelets more than 1 at each node.
  Spikelets 1-flowered ---------- 2. *Hordeum*.
  Spikelets more than 1-flowered.
    Stem of spike continuous, not disjointing ---- 3. *Elymus*.
    Stem of spike not continuous, disjointing ---- 4. *Sitanion*.

1. STIPA L. Needlegrass.

Bunch-grass with very narrow leaves.

Awn with 2 bends.
  Ligule 3-6 mm. long ---------- 1. *S. Thurberiana*.
  Ligule very short ---------- 2. *S. occidentalis*.

1. *Stipa Thurberiana* Piper. Thurber Needlegrass. A foot high or higher. —Indian Well, Bearpaw Butte.

2. *Stipa occidentalis* Thurb. Western Needlegrass. Taller with longer heads.—Caldwell Butte.

2. PHLEUM L. Timothy.

1. *Phleum pratense* L. Common Timothy. Occasional along roadsides.

3. KOELERIA Pers.

1. *Koeleria cristata* (L) Pers. Junegrass. The head spike-like early, becoming loose later. A common bunch-grass.—Bearpaw Butte, Devil's Homestead.

4. BROMUS L.

Annual; turning red; introduced weed ---------- 1. *B. tectorum*.
Perennial; tall, broad-leaved ---------- 2. *B. carinatus*.

1. *Bromus tectorum* L. Downy Brome. Bronco Grass. Extremely abundant almost all over the entire region, especially the north half. This European grass was probably brought in by sheep. It has filled in the spaces between the original bunch-grass. Drying early in the season, it has furnished material for running fires, and has thus become the greatest fire hazard of the area.

2. *Bromus carinatus* Hook. & Arn. Tall Brome Grass. *(B. marginatus* Nees). Only sparingly abundant; more common in the upper section of the monument, especially among the ponderosa pines along the western border.

5. FESTUCA L.

Annual; introduced weed; not usually bunched____1. *F. octoflora.*
Perennial; native grass; densely bunched_____2. *F. idahoensis.*

1. *Festuca octoflora* Walt. A common usually low "cheat" grass, scattered pretty well over the entire area.—Stronghold, Devil's Homestead.

2. *Festuca idahoensis* Elmer. Blue Bunchgrass. A fairly common native densely tufted bunch-grass; often turning reddish or purplish.—Indian Well, Bearpaw Butte.

6. POA L. Bluegrass.

1. *Poa juncifolia* Scribn. Rush-leaved Bluegrass. *(P. brachyglossa* Piper). One of the most common species of bunchgrass; narrow leaves and smooth flowerparts; stems densely tufted.—Indian Well, Stronghold, Bearpaw and Sconchin Buttes.

7. AGROPYRON Gaertn. Wheatgrass.

1. *Agropyron spicatum* (Pursh) Scribn. and Smith. Spiked Wheatgrass. Plants with many tall slender stems and narrow heads, forming large and dense bunches. The most abundant bunchgrass in the upper section of the monument.—Indian Well, Bearpaw Butte, etc.

8. HORDEUM L. Wild Barley.

1. *Hordeum murinum* L. Foxtail. Sparingly introduced along the north boundary.

9. ELYMUS L. Ryegrass.

1. *Elymus condensatus* Presl. Giant Ryegrass. A very tall coarse grass with broad flat leaves, growing in large dense clumps.—Rather common toward the north end of the area. In early days much prized as a forage plant when lower grasses were covered by snow.

10. SITANION Raf.

1. *Sitanion hystrix* (Nutt.) J. G. Smith. Squirrel-tail. An abundant bunchgrass with barley-like heads provided with many long rigid awns. At maturity the heads disjoint readily and are scattered by wind.

4. *Juncaceae*. Rush Family.

1. JUNCUS L. Rush.

1. *Juncus mexicanus* Willd. Mexican Rush. The only Rush seen in the monument area: in broken lava rocks on the northern border opposite the Stronghold.

5. *Liliaceae.* Lily Family.

Styles 3 and distinct.....1. *Zygadenus.*
Style 1.
  Flowers in a cluster on the ground.....2. *Leucocrinum.*
  Flowers on a single stem.
    Flower-parts (perianth segments) unlike, the inner large and showy.....3. *Calochortus.*
    Flower-parts alike.....4. *Fritillaria.*

1. ZYGADENUS Michx.

1. *Zygadenus paniculatus* (Nutt.) S. Wats. Sand Corn. The long narrow bright green leaves sheathing the lower part of a single stem which bears an elongated cluster of rather small white flowers.—Well distributed but not abundant.

2. LEUCOCRINUM Nutt.

1. *Leucocrinum montanum* Nutt. Sand Lily. The delicate fragrant flowers pure white with a very long tube, growing from a tuft of grass-like gray-green leaves.—Infrequent: deep pumice sand in the crater of Caldwell Butte and on the southerly slope of Eaglenest Butte.

3. CALOCHORTUS Pursh.

1. *Calochortus macrocarpus* Dougl. Desert Lily. 12-18 inches high; the large purplish flowers very showy.—Common in the sagebrush: especially abundant in the vicinity of Skull Cave and along the road above.

4. FRITILLARIA L.

1. *Fritillaria pudica* (Pursh) Spreng. Gold-Bell. The single stem about 6 inches high, bearing several rather narrow leaves above the middle and one or more golden-yellow bell-shaped flowers.—Rare in our area; flowering very early.

6. *Salicaceae.* Willow Family.

Leaves broad; flowers with a disk and numerous stamens.....1. *Populus.*
Leaves narrow; flowers with a bract and few stamens.....2. *Salix.*

1. POPULUS L. Poplar.

1. *Populus tremuloides* Michx. Quaking Aspen. A small white-barked tree with roundish leaves.—Rare in our area: seen only along the Medicine Lake road near the Heppe Cave road where there is a grove of about 200 trees.

2. SALIX L. Willow.

A shrub on the south border.....1. *S. Scouleriana.*
A tree on the north border.....2. *S. lasiandra.*

1. *Salix Scouleriana* Barr. Scouler Willow. Rare in the pine woods along the southern border.

2. *Salix lasiandra* Benth. Yellow Willow. Shoreline of Tule Lake.

7. *Fagaceae.* Oak Family.

1. CASTANOPSIS Spach.

1. *Castanopsis sempervirens* (Kell.) Dudley. Bush Chinquapin. Among ponderosa pines at south border.

8. *Urticaceae.* Nettle Family.

1. URTICA L. Nettle.

1. *Urtica holosericea* Nutt. Hoary Nettle. Frequent along the north border.

9. *Loranthaceae.* Mistletoe Family.

Growing on junipers ..... 1. *Phoradendron*
Growing on pines ..... 2. *Arceuthobium.*

1. PHORADENDRON Nutt.

1. *Phoradendron densum* Torr.

2. ARCEUTHOBIUM Marsch.-Bieb.

2. *Arceuthobium campylopoda* Engelm.

10. *Polygonaceae.* Buckwheat Family.

Flowers in an involucre ..... 1. *Eriogonum.*
Flowers not involucrate.
  Sepals 5 ..... 2. *Polygonum.*
  Sepals 6 ..... 3. *Rumex.*

1. ERIOGONUM Michx.

Shrubby, bush-like with shreddy bark ..... 1. *E. microthecum.*
Perennial herbs.
  Plant with a spreading woody base ..... 2. *E. umbellatum* var.
  Plant with tall usually hollow stems and spreading broad basal leaves ..... 3. *E. nudum* and var.
  Plant matted.
    Stem short, bearing a solitary head of reddish flowers ..... 4. *E. ovalifolium* var.
    Stem taller, bearing umbels of yellow flowers ..... 5. *E. proliferum.*
Annual; leaves in a basal rosette ..... 6. *E. vimineum.*

1. *Eriogonum microthecum* Nutt. Bush Eriogonum. Usually growing in rather large well-rounded bushes with umbels of whitish flowers.—More often seen on the slopes and about the bases of the cinder cones, especially Caldwell, Sconchin, and Juniper Buttes.

2. *Eriogonum umbellatum polyanthum* (Benth.) Jones. Sulphur Flower. The tall naked stems from a branched woody base, bearing umbels of many-flowered heads and leaf-like involucral bracts.—Common.

3. *Eriogonum nudum* Dougl. Naked-stem Eriogonum. Flowers white.—More common toward the southern section: Medicine Lake road, Upper Ice Cave. *E. nudum pubiflorum* Benth. is a taller form with deep yellow flowers which are more or less hairy toward the base.—Caldwell Butte, Indian Well, and Three Sisters.

4. *Eriogonum ovalifolium vineum* A. Nelson. Growing in dense cushion-like mats with reddish flowers in small single heads on short stems.—Less common than the other species: Upper Ice Cave.

5. *Eriogonum proliferum* Torr. & Gray. Widely distributed: Capt. Jack's Ice Cave, Bearpaw Cave, Devil's Homestead.

6. *Eriogonum vimineum* Dougl. Usually rather low, much branched from

near the base, with rose-colored flowers.—Common around Indian Well and Caldwell Butte.

2. POLYGONUM L. Knotweed.

1. *Polygonum Muhlenbergii* S. Watson. Muhlenberg Knotweed. Plant with tall stems, large pointed leaves and a spike of red flowers.—The large clumps are conspicuous among the broken lava rocks along the old shoreline of Tule Lake opposite the Stronghold.

3. RUMEX L. Dock.

1. *Rumex cuneifolius* Cambd. Sand Dock. Stems 6 inches or more high; the leaves broadly willow-like with the bases sheathed with papery bracts; the small greenish-yellow flowers in an elongated spray.—Abundant at Hospital Rock, Petroglyph Bluff and other places along the Tule Lake shoreline.

11. *Chenopodiaceae*. Saltbush Family.

Stamens and pistils in the same flower.
  Leaves stiff and spiny ..... 1. *Salsola.*
  Leaves not spiny ..... 2. *Chenopodium.*
Stamens and pistils in separate flowers.
  Shrub ..... 3. *Grayia.*
  Herb ..... 4. *Atriplex.*

1. SALSOLA L. Russian Thistle.

1. *Salsola pestifer* A. Nelson. Troublesome tumble-weed just beginning to invade our area.

2. CHENOPODIUM L. Pigweed. Goosefoot.

Leaves broad ..... 1. *C. album.*
Leaves narrow ..... 2. *C. leptophyllum.*

1. *Chenopodium album*. L. White Pigweed. Naturalized weed of roadsides, etc.

2. *Chenopodium leptophyllum* S. Watson. Narrow-leaved Pigweed. Widely distributed.

3. GRAYIA Hook. & Arn.

1. *Grayia spinosa* (Hook.) Moq. Hop Sage. A much branched shrub with conspicuous round fruiting bracts.—About Hospital Rock and on top of Petroglyph Bluff.

4. ATRIPLEX L. Saltbush.

1. *Atriplex argentea* Nutt. Silver Saltbush. An abundant tumble-weed, especially in low ground along the shore of Tule Lake, where it is taller and much branched.

12. *Portulacaceae*. Purslane Family.

Annual; root fibrous ..... 1. *Montia.*
Perennial; root thick ..... 2. *Lewisia.*

1. MONTIA L.

Stamens 5; leaves broad ..... 1. *M. perfoliata.*
Stamens 3; leaves narrow ..... 2. *M. linearis.*

1. *Montia perfoliata* (Donn.) Howell. Indian Lettuce. A small succu-

lent plant with a pair of leaves united into a disk around the stem. Often found in lava trenches and in the shade of rock walls. *M. perfoliata depressa* (Gray) Jepson is a smaller form with reddish leaves found in more exposed situations.

2. *Montia linearis* (Dougl.) Greene. A dwarf plant with small white nodding flowers and long narrow leaves with clasping base.—Rare in the region: Fleener road.

2. LEWISIA Pursh.

1. *Lewisia rediviva* Pursh. Plant about an inch or two high; stemless, reddish, flowers pink. A dwarfed form.—Rare.

13. *Caryophyllaceae*. Pink Family.

Sepals distinct ..... 1. *Arenaria.*
Sepals united ..... 2. *Silene.*

1. ARENARIA L. Sandwort.

Annual, erect ..... 1. *A. Douglasii.*
Perennial, matted ..... 2. *A. Nuttallii.*

1. *Arenaria Douglasii* Fenzl. Douglas Sandwort. A small weed-like plant with only stem-leaves and small flowers.—Caldwell Butte.

2. *Arenaria Nuttallii* Pax. Nuttall Sandwort. Plant with a clump of sharp needle-like leaves, erect stems and phlox-like white flowers.—Not common in our area: noted on a cinder cone in the black lava flow in the southwest corner.

2. SILENE L. Catchfly.

1. *Silene Douglasii multicaulis* (Nutt.) Robinson. Many-stemmed Douglas Catchfly. This white-flowered species forms rather close clumps with narrow mostly basal leaves.—Widely distributed: Bearpaw, Caldwell, and Hippo Buttes, and common about Indian Well.

14. *Ranunculaceae*. Buttercup Family.

Flowers regular.
  Flowers conspicuous, shiny-yellow ..... 1. *Ranunculus.*
  Flowers minute, white, in a spike ..... 2. *Myosurus.*
Flowers irregular ..... 3. *Delphinium.*

1. RANUNCULUS L. Buttercup.

1. *Ranunculus glaberrimus* Hook. Sagebrush Buttercup. This attractive smooth buttercup is often seen in the broken-down lava tubes, and is especially abundant on the northerly slope of Caldwell Butte. A very early bloomer.

2. MYOSURUS L.

1. *Myosurus aristatus* Benth. Mousetail. This dwarf plant (2 or more inches high) with a tuft of slender leaves and a narrow spike-like head of very minute white flowers was collected on Hospital Rock.

3. DELPHINIUM L. Larkspur.

Flowers red ..... 1. *D. nudicaule.*
Flowers blue.

Roots large and much branched.....2. *D. Andersonii.*
Roots small and tuberous.....3. *D. depauperatum.*

1. *Delphinium nudicaule* Torr. and Gray. Red Larkspur. Found only on Caldwell Butte, from top to base, and extending into the sagebrush as far as the road leading to Caldwell Ice Caves.

2. *Delphinium Andersonii* Gray. Anderson Larkspur. The common species of the region.—A striking plant on the steep slopes of the cinder cones, especially Caldwell and Sconchin Buttes.

3. *Delphinium depauperatum* Nutt. Dwarf Larkspur. A usually smaller and more delicate plant than the last. To be expected along the southern border near the Medicine Lake road. Common southward in the Medicine Lake region.

15. *Papaveraceae.* Poppy Family.

1. *Eschscholtzia californica* Cham. California Poppy. Only an occasional colony, including the following stations: Hospital Rock, Sand Hill, and Caldwell Butte. On the easterly slope of the last is the largest and finest, where they grow in large clumps with unusually thick roots which penetrate deeply into the loose cinders and pumice. The flowers are yellow throughout our area, never orange.

16. *Cruciferae.* Mustard Family.

Flowers yellow.
  Seeds in 1 row in the pod.
    Leaves simply lobed.....1. *Sisymbrium.*
    Leaves finely divided.....2. *Descurania.*
    Leaves entire or nearly so.....3. *Erysimum.*
  Seeds in 2 rows in the pod.....4. *Nasturtium.*
Flowers white or purple.
  Petals broad at the base; pods narrow.
    Pod roundish; flowers white.....5. *Smelowskia.*
    Pod flattish; flowers purple.....6. *Arabis.*
  Petals narrow at the base; flowers purple.
    Pod narrow and round.....7. *Thelypodium.*
    Pod broad and flat.....8. *Parrya.*

1. SISYMBRIUM L.

1. *Sisymbrium altissimum* L. Jim Hill Mustard. This tall weed is common, adding to the fire hazard.

2. DESCURAINIA Webb. & Benth.

Pods long with seeds in 1 row.....1. *D. Sofia.*
Pods short with seeds in 2 rows.....2. *D. pinnata.*

1. *Descurainia Sofia* (L.) Webb. Flix Weed.

2. *Descurainia pinnata* (Walt.) Britton. Tansy Mustard. These little mustards with their finely cut leaves and small yellow flowers are very similar in general aspect, and can be seen almost everywhere.

3. ERYSIMUM L. Wall Flower.

1. *Erysimum asperum perenne* S. Wats. Wall Flower.—Not common; occasional on Caldwell Butte.

4. NASTURTIUM R. Brown. Watercress

1. *Nasturtium curvisiliqua* (Hook.) Nutt. Yellow Watercress.—A common naturalized weed found along the shore of Tule Lake.

5. SMELOWSKIA C. A. May.

1. *Smelowskia Fremontii* S. Watson. A small tufted plant with finely cut leaves and smallish white flowers, usually found in flats.—Common near Fleener ranch. First collected near Klamath Lake in 1846 by Fremont.

6. ARABIS. L. Rockcress.

Pods straight, reflexed	1. *A. Holboellii* var.
Pods curved, spreading	2. *A. sparsiflora* var.

1. *Arabis Holboellii secunda* (Howell) Jepson.

2. *Arabis sparsiflora peramoena* (Greene) Rollins. These two tall rather showy-flowered species look much alike but can be readily separated by the shape and disposition of the pods.

7. THELYPODIUM Endl.

1. *Thelypodium flexuosum* Robinson. A tall plant, much branched at the base; ofen growing in and supported by sagebrush.—Fleener's ranch.

8. PARRYA R. Brown.

1. *Parrya Menziesii* (Hook.) Greene. A low plant with thick perennial root, numerous basal leaves and clusters of showy flowers; stems and pods spreading horizontally.—Rare in our area; Top of Gillem Bluff near Fleener road.

17. *Saxifragaceae*. Saxifrage Family.

Herbs.	
Stamens 10	1. *Lithophragma.*
Stamens 5	2. *Heuchera.*
Shrubs	3. *Ribes.*

1. LITHOPHRAGMA Nutt.

1. *Lithophragma rupicola* Greene. Small plant with simple slender stem, mostly basal leaves and delicate pinkish-white flowers; the petals usually 3-cleft.

2. HEUCHERA L. Alum Root.

2. *Heuchera ovalifolia* Nutt. Oval-leaved Alum Root. The small white flowers in a spike-like cluster on rather tall scape-like stems, surrounded at the base by roundish leaves.—Plentiful in pine woods; abundant on Caldwell Butte.

3. RIBES L. Gooseberry. Currant.

Plant with spines.	
Berry with spines; leaves shiny-green	1. *R. cruentum*
Berry smooth; leaves gray-green	2. *R. velutinum.*
Plants without spines	3. *R. cereum.*

1. *Ribes cruentum* Greene. Spiny-fruited Gooseberry.—Rare: north slopes in pine woods. Caldwell Butte.

2. *Ribes velutinum* Greene. Desert Gooseberry. A species with stiff

curved branches beset with mostly solitary stout spines.—A characteristic shrub of the region. Abundant about Indian Well.

3. *Ribes cereum* Dougl. Waxy Currant. Foliage sticky-glandular; berries reddish-yellow.—Found in all parts of the region.

18. *Rosaceae*. Rose Family.

Shrubs.
- Leaves simple.
  - Flowers small, creamy-white in large sprays—1. *Holodiscus*
  - Flowers larger, white in compact clusters.
    - Fruit a drupe—2. *Prunus*.
    - Fruit a bluish berry—3. *Amelanchier*.
  - Flowers yellow; leaves 3-toothed at apex—4. *Purshia*.
  - Flowers with feathery-tailed seeds—5. *Cercocarpus*.
- Leaves pinnately compound.
  - Flowers white; leaflets minute—6. *Chamaebatiaria*.
  - Flowers pink; leaflets large—7. *Rosa*.

Herbs.
- Flowers yellow—8. *Potentilla*.
- Flowers pinkish—9. *Geum*.

1. Holodiscus Maxim. Ocean Spray.

1. *Holodiscus glabrescens* (Greenman) Heller. Desert Ocean Spray. Scattered from the Stronghold to the Mammoth Crater.—Lava ledges, cliffs and crests of cinder cones.

2. Prunus L.

Flowers in flat-topped clusters; fruit light-red, bitter 1. *P. emarginata*.
Flowers in elongated clusters; fruit dark-red—2. *P. demissa*.

1. *Prunus emarginata* (Dougl). Walp. Bitter Cherry.—Common, but more abundant in the caves and cinder cone area; a number of large bushes at Indian Well.

2. *Prunus demissa* (Nutt.) Dietr. Choke Cherry.—Not as common: noted at the Stronghold and at Caldwell Butte.

3. Amelanchier Medic. Service.

1. *Amelanchier pallida* Greene. Pale-leaved Serviceberry. Tall much branched bushes with grayish-red bark, roundish toothed leaves and snowy-white flower-clusters.—Frequent: Stronghold, Indian Well, Bearpaw, and Caldwell Buttes.

4. Purshia DC.

1. *Purshia tridentata* (Pursh) DC. Bitter Brush. Perhaps the most abundant shrub in our area; dominant over the upper half, giving a darker cast to the landscape than where the sagebrush is more common.

5. Cercocarpus HBK.

1. *Cercocarpus ledifolius* Nutt. Desert Mahogany. A tall shrub or scraggy tree with narrow leathery leaves and small pinkish flowers with con-

spicuously long-tailed carpels.—Abundant around Indian Well and all of the upper part of the monument area.

6. CHAMAEBATIARIA Maxim.

1. *Chamaebatiaria millefolium* (Torr.) Maxim. Fern Shrub. Widely distributed; always seen about the cave entrances where it grows in usually large clumps of cane-like branches, clothed with finely dissected fern-like foliage and attractive rather large white flowers; the leaves and flowers gummy and strong scented.

7. ROSA L. Rose.

1. *Rosa ultramontanus* (S. Watson) Heller. Interior Rose. Not often seen: on the northern border in broken lava opposite Capt. Jack's Stronghold.

8. POTENTILLA L. Five-finger.

1. *Potentilla glandulosa* Lindl. Glandular Five-finger. The several stems a foot or so high bearing an open cluster of pale-yellow flowers about the size of the common buttercup of the region.—Bearpaw, Hippo, and Caldwell Buttes, etc.

9. GEUM L.

1. *Geum triflorum* Willd. Whiskers. The clustered stems a foot or less high, commonly bearing 3 flowers; the seed-tails long and feathery.—Rare: Crescent Butte and east base of Bearpaw Butte.

19. *Leguminosae*. Pea Family.

Leaves palmate; calyx 2-lipped ..... 1. *Lupinus*.
Leaves pinnate with a tendril ..... 2. *Vicia*.
Leaves pinnate without a tendril ..... 3. *Astragalus*.

1. LUPINUS L. Lupine.

Perennial, tall, smooth ..... 1. *L. corymbosus*.
Annual, low, hairy ..... 2. *L. subvexus*.

1. *Lupinus corymbosus* Heller. Field Lupine. Often very much branched from the base, forming large bush-like rounded clumps.—Seen on the Tule Lake Peninsula near Petroglyph Bluff.

2. *Lupinus subvexus transmontanus* C. P. Smith. Low flats.—Noted along the Lyons road near the north boundary.

2. VICIA L. Vetch.

1. *Vicia americana* Muhl. American Vetch. Not often seen: Thomas Massacre area.

3. ASTRAGALUS L. Loco-weed. Rattle-pod.

Pod strongly inflated ..... 1. *A. lentiginosus*.
Pod not strongly inflated.
  Pod roundish, slightly curved ..... 2. *A. Gibbsii*.
  Pod flat, strongly curved ..... 3. *A. Whitedii*.
  Pod straight ..... 4. *A. filipes*.
  Pod densely white-wooly ..... 5. *A. glariosus*.

1. *Astragalus lentiginosus* Dougl. Rattle-pod. Low ground, as along the Lyons road near the north boundary: Hospital Rock.

2. *Astragalus Gibbsii* Kellogg. Gibbs Loco-weed. Sagebrush: Gillem Bluff, lower Lyons road.

3. *Astragalus Whitedii* Piper. Whited Loco-weed. Lower Lyons road.

4. *Astragalus filpes* Torr. Narrow-pod Loco-weed. More common than the other species.—Lyons road, Thomas Massacre area, Caldwell Butte, Petroglyph Bluff.

5. *Astragalus glariosus* Dougl. Wooly-pod Loco-weed. A densely tufted low plant.—Sheepherder's road, Sand Hill, crater of Caldwell Butte.

20. *Geraniaceae.* Geranium Family.

1. ERODIUM L'Her.

1. *Erodium circutarium* (L.) L'Her. Red-stem Filaree. Sparingly introduced.

21. *Linaceae.* Flax Family.

1. LINUM L. Flax.

1. *Linum Lewisii* Pursh. Lewis Flax. Blue Flax. Common: Indian Well.

22. *Rhamnaceae.* Buckthorn Family.

1. CEANOTHUS L.

Leaves large and shiny; flowers in large white clusters.....1. *C. velutinus.*
Leaves small and toothed; flowers in small bluish clusters.....2. *C. prostratus.*

1. *Ceanothus velutinus* Dougl. Snow Brush. Large upright bushes in pine woods of southern border and easterly slopes of cinder cones.—Caldwell, Hippo, Bearpaw Buttes.

2. *Ceanothus prostratus* Benth. Squaw Carpet. Forming mats.—Usually associated with the last.

23. *Violaceae.* Violet Family.

1. VIOLA L. Violet.

1. *Viola venosa* (S. Wats.) Rydb. Desert Violet. This small yellow-flowered violet is found chiefly on the exposed slopes of the cinder cones.

24. *Loasaceae.*

1. MENTZELIA L.

Flowers small.....1. *M. albicaulis.*
Flowers large.....2. *M. laevicaulis.*

1. *Mentzelia albicaulis* Dougl. White-stem Mentzelia. Usually low; rough plant with simple or branched stem.—Common: Indian Well.

2. *Mentzelia laevicaulis* (Dougl.) T. & G. Blazing Star. A strikingly showy much branched plant with large yellow flowers.—Caldwell Butte.

25. *Onagraceae.* Evening Primrose Family.

Seeds with a tuft of long hairs.....1. *Epilobium.*
Seeds naked.
  Flowers minute, white or pinkish.....2. *Gayophytum.*
  Flowers larger.
    Flowers yellow or white.....3. *Oenothera.*
    Flowers purple.....4. *Godetia.*

1. EPILOBIUM L. Willow Herb.

Stems simple, reddish ..... 1. *E. minutum.*
Stems branched, shiny-white ..... 2. *E. paniculatum*

1. *Epilobium minutum* Lindl. Desert Willow Herb. Common on rock ledges.

2. *Epilobium paniculatum* Nutt. Often tall and much branched.—Caldwell Butte.

2. GAYOPHYTUM Juss.

Pedicels almost none; stem leafy ..... 1. *G. caesium.*
Pedicels longer; leaves scattered ..... 2. *G. ramosissimum.*

Gayophytum caesium Torr. & Gray. A low plant with minute flowers.—About the cinder cones.

2. *Gayophytum ramosissimum* Torr. & Gray. Taller and much branched.—Common.

3. OENOTHERA L. Evening Primrose.

Flowers yellow; leaves pinnately cleft ..... 1. *O. tanacetifolia.*
Flowers white, turning pinkish; leaves simple ..... 2. *O. caespitosa.*

1. *Oenothera tenacetifolia* Torr. & Gray. Tansy-leaved Evening Primrose. Lying flat on the ground; growing in low alkaline flats.—Fleener ranch.

2. *Oenothera caespitosa* Nutt. Matted Evening Primrose. Flowers showy, over an inch long.—Near Petroglyph Bluff, on the talus slope of Tule Lake Peninsula.

4. GODETIA Spach.

1. *Godetia quadrivulnera* (Dougl.) Spach. Stem usually simple, leafy, 6 inches to a foot or more high.—To be seen about Indian Well.

26. *Umbelliferae.* Parsley Family.

1. LOMATIUM Raf.

Leaf-segments long and narrow ..... 1. *L. alatum.*
Leaf-segments finely dissected ..... 2. *L. nevadense.*

1. *Lomatium alatum* Coulter and Rose. Tall Hog Fennel. Occasional in the sagebrush along Gillem Bluff and at Canby Cross.

2. *Lomatium nevadense* (S. Wats.) Coulter & Rose. Collected at north base of Caldwell Butte, and at Petroglyph Bluff. The involucral bracts have papery margins.

27. *Ericaceae.* Heath Family.

1. ARCTOSTAPHYLOS Adans. Manzanita.

1. *Arctostaphylos patula* Greene. Green Manzanita. Associated with ponderosa pines.—Southern border, Caldwell, Hippo, Bearpaw, and other cinder cones.

28. *Gentianaceae.* Gentian Family.

1. FRASERA Walt.

1. *Frasera albicaulis* Dougl. White-stem Green Gentian. Flowers light blue on stems 6 inches or more high, the narrow leaves mostly basal.—Common in sandy places: Hippo, Caldwell, and Bearpaw Buttes.

29. *Apocynaceae*. Dogbane Family.

Plant erect with small flowers ..... 1. *Apocynum.*
Plant low with large flowers ..... 2. *Cycladenia.*

1. APOCYNUM L.

1. *Apocynum androsaemifolium* L. Indian Hemp. A leafy branched herb with milky juice and small bell-shaped flowers and double pods.—Occurring sparingly in the upper part of the area, usually among pines, as around the Upper Ice Cave.

2. CYCLADENIA Benth.

1. *Cycladenia humilis* Benth. The short stems flat on the ground, the large roundish leaves smooth and leathery; the deep rose-colored corollas funnel-form, nearly an inch long; the large fleshy root penetrates deeply into the cinders and pumice.—This curious and interesting plant is found only on the exposed slopes of some of the cinder cones, including Caldwell, Bearpaw, Sconchin, and Island Buttes.

30. *Polemoniaceae*. Gilia Family.

Plants with woody base.
  Plants matted ..... 1. *Phlox.*
  Plants erect ..... 2. *Leptodactylon.*
Plants with herbaceous base.
  Leaves pinnate.
    Leaf lobes distinct ..... 3. *Polemonium.*
    Leaf lobes not distinct ..... 4. *Gilia.*
  Leaves simple, entire.
    Angle of calyx lobes extended lobe-like ..... 5. *Collomia.*
    Angle of calyx lobes not extended ..... 1. *Phlox.*

1. PHLOX L.

Perennial ..... 1. *P. Douglasii.*
Annual ..... 2. *P. gracilis.*

1. *Phlox Douglasii* Hook. Douglas Phlox. Growing in dense large mats with abundant purplish or pinkish attractive flowers.—Well scattered over the area: Indian Well, Lyons road.

2. *Phlox gracilis* (Hook.) Greene. A small annual weed with minute pinkish flowers.—Abundant in low ground along the Lyons road near the northern border.

2. LEPTODACTYLON Hook. & Arn.

1. *Leptodactylon pungens* (Torr.) Nutt. Desert Phlox. The many woody stems densely clothed with palmately divided leaves, the lobes sharp and needle-like; flowers creamy-white, phlox-like.—Common about such places as Capt. Jack's Stronghold, Three Sisters, etc.

3. POLEMONIUM L.

1. *Polemonium micranthum* Benth. Small Jacob's Ladder. A common weed 6 inches or less high with small white flowers and a skunk-like odor.—Plentiful in low flats along the north border.

4. GILIA R. & P.

Perennial; flowers white ..... 1. *G. congesta.*
Annual; flowers blue ..... 2. *G. inconspicua.*

1. *Gilia congesta montana* (Nels. & Ken.) Constance & Rollins. The small white flowers in dense heads.—A plant of exposed cinder slopes: more common on Caldwell Butte.

2. *Gilia inconspicua* (Smith) Hook. Stems mostly 6-8 inches high, surrounded at the base by a rosette of lobed leaves.—A desert plant found throughout the region: Stronghold, Sheepherder's road, Lyons road, etc. A variable plant of doubtful identity.

5. COLLOMIA Nutt.

Plant low; flowers small ..... 1. *C. tinctoria.*
Plant taller; flowers larger, showy ..... 2. *C. grandiflora.*

1. *Collomia tinctoria* Kellogg. A small weed-like plant.—Caldwell Butte, Upper Ice Cave.

2. *Collomia grandiflora* Dougl. Infrequent; flowers nearly an inch long, yellow. Bearpaw Butte.

31. *Hydrophyllaceae.* Phacelia Family.

Flowers minute, purple, in small clusters ..... 1. *Nama.*
Flowers larger, in spike-like coils ..... 2. *Phacelia.*

1. NAMA L.

1. *Nama densum* Lemmon. Small low plants in sandy places.

2. PHACELIA Juss.

Perennials with pinnate leaves.
  Leaves with a small pair of leaflets at the base ..... 1. *P. leucophylla.*
  Leaves with a large terminal lobe ..... 2. *P. californica.*
  Plants with long weak stems ..... 3. *P. ramosissima.*
Annuals.
  Leaves linear, entire ..... 4. *P. linearis.*
  Leaves broad, finely divided ..... 5. *P. bicolor.*

1. *Phacelia leucophylla* Torr. One of the many forms of this variable group.—Occasionally seen under pines: Bearpaw Butte. Another form, more condensed and with a strong deep-seated root, occurs on the steep exposed slopes of the cinder cones. This seems to be near *P. heterophylla compacta* (Greene) Jepson.

2. *Phacelia californica virgata* (Greene) Jepson. This plant is even more confusingly variable than the preceding. It is rough, often much branched, but frequently having a single stem 2 or 3 feet in height, standing out very conspicuously on the dry lava ridges.—Common, for example, at Indian Well.

3. *Phacelia ramosissima* Dougl. Characteristic of the more rugged sections, and the slopes of the cinder cones, sometimes draped over rocks and bushes.—Broken rocks of the north border opposite the Stronghold, Caldwell, and Sconchin Buttes, Mammoth Crater.

4. *Phacelia linearis* (Pursh) Holz. Abundant over most of the region.—Stronghold, Sheepherder's and Lyons road, Indian Well.

5. *Phacelia bicolor* Torr. Corolla purple with a white tube.—Rare: seen only on tope of Petroglyph Bluff where it is quite abundant. To be expected within the main area of the monument.

32. *Boraginaceae.* Borage Family.

Flowers blue.
  Perennial; flowers showy ..... 1. *Hackelia.*
  Annual; flowers inconspicuous ..... 2. *Lappula.*
Flowers yellow ..... 3. *Amsinckia.*
Flowers white.
  Nutlets attached from the base ..... 4. *Cryptantha.*
  Nutlets attached from the middle ..... 5. *Plagiobothrys.*

1. Hackelia Pohl.

1. *Hackelia Cusickii* (Piper) Brand. Cusick Stickweed. Always under juniper trees. The flowers resemble Forget-me-not.—Rare: Devil's Homestead along the base of Gillem Bluff.

2. Lappula Moench.

1. *Lappula Redowskii desertorum* (Greene) Johnston. An erect slender weed-like annual with small bluish flowers.—Common along the trail leading into the Stronghold.

3. Amsinckia Lehm.

1. *Amsinckia tessellata* Gray. Fiddleneck. Not abundant: more common along Gillem Bluff in the vicinity of Gillem Camp.

4. Cryptantha Lehm.

Perennial; rough stout plant ..... 1. *C. Sheldonii.*
Annual; slender plants.
  Surface of nutlets smooth and shining.
    Fruiting calyx 4 mm. long ..... 2. *C. Watsonii.*
    Fruiting calyx 4.5-6 mm. long ..... 3. *C. Torreyana.*
  Surface of nutlets rough.
    Plant much branched; pubescence stiff ..... 4. *C. ambigua.*
    Plant little branched; pubescence softer ..... 5. *C. Hendersonii.*

1. *Cryptantha Sheldonii* (Brand) Payson. Seen only on the southerly slope of Caldwell Butte; deeply rooted in cinders and pumice sand; associated with *Cycladenia* and *Gilia congesta.* Not typical of the species.

2. *Cryptantha Watsonii* (Gray) Greene.

3. *Cryptantha Torreyana* (Gray) Greene.

4. *Cryptantha ambigua* (Gray) Greene.

5. *Cryptantha Hendersonii* (Nelson) Piper. Superficially these little annuals appear much alike.—Scattered generally over the entire area.

5. Plagiobothrys F. & M. Pop-corn.

1. *Plagiobothrys tenellus* (Nutt.) Gray. Low (usually 3-4 inches) hairy plants with a tuft of basal leaves.—Common in sagebrush on top of Gillem Bluff.

33. *Menthaceae.* Mint Family.

Shrub ..... 1. *Salvia.*
Perennial herbs.

Corolla nearly regular ..... 2. *Monardella.*
Corolla 2-lipped.
  Calyx with 10 hooked teeth ..... 3. *Marrubium.*
  Calyx with 5 straight teeth ..... 4. *Agastache.*
  Calyx with 2 lips ..... 5. *Scutellaria.*

1. SALVIA L. Sage.

1. *Salvia carnosa* Dougl. Desert Sage. A grayish bush; the conspicuous purple flowers in whorls.—Common everywhere; Indian Well, Devil's Homestead, etc.

2. MONARDELLA Benth.

1. *Monardella odoratissima* Benth. Desert Mint. A fragrant shrub-like herb stiffly branched from a woody base, the large dense heads of lavender-colored flowers surrounded by broad colored bracts.—Frequent, especially throughout the caves; Indian Well, Caldwell Butte.

3. MARRUBIUM L.

1. *Marrubium vulgare* L. Common Horehound. Sparingly introduced.

4. AGASTACHE Clayt.

1. *Agastache urticifolia* (Benth.) Ktse. var. A very strong scented herb with many stems branching from the base; flowers with pinkish calyx and purplish corolla in a close spike.—Conspicuous about the caves in the vicinity of Indian Well and other similar places, the aromatic odor particularly noticeable. Our plant not typical, differing in having more slender stems and smaller leaves.

5. SCUTELLARIA L.

1. *Scutellaria nana* Gray. Dwarf Skullcap. A low mat-like plant with gray foliage and long creamy-white flowers, large for the size of the plant; the slender rootstocks bearing small tubers.—Growing in sandy places, infrequent. In the crater of Caldwell Butte among bushes of *Cercocarpus.*

34. *Solanaceae.* Nightshade Family.

Fruit a capsule; corolla long-tubular ..... 1. *Nicotiana.*
Fruit a berry; corolla wheel-shaped ..... 2. *Solanum.*

1. NICOTIANA L. Tobacco.

1. *Nicotiana attenuata* Torr. Indian Tobacco. An erect sticky plant with rather large white flowers; corolla with a very slender tube and spreading lobes.—Sandy and waste places.

2. SOLANUM L. Nightshade.

1. *Solanum villosum* Mill. Hairy Nightshade. A low spreading leafy plant with yellow berries.—Rare except along the rocky shores of Tule Lake. Noted at Bearpaw Butte. Naturalized from Europe.

35. *Scrophulariaceae.* Figwort Family.

Leaves opposite.
  Annual; stamens 4.
    Flowers blue and white ..... 1. *Collinsia.*
    Flowers red or yellow ..... 2. *Mimulus.*

Perennial; stamens 5, 1 without anther.
Corolla short and broad; 4 lobes erect, the lower one reflexed ..... 3. *Scrophularia.*
Corolla long and more slender; all of the lobes more or less erect or spreading, 3 below ..... 4. *Pentstemon.*
Leaves alternate; stamens 4; corolla very definitely 2-lipped ..... 5. *Castilleja.*

1. Collinsia Nutt.

1. *Collinsia parviflora* Dougl. Small-flowered *Collinsia.* A small weak-stemmed smooth plant.—Common everywhere.

2. Mimulus L. Monkey-flower.

Flowers yellow ..... 1. *M. rubellus.*
Flowers red ..... 2. *M. nanus.*

1. *Mimulus rubellus* Gray. Diminutive plants with narrow short-lobed corolla.—Common along ledges.

2. *Mimulus nanus* Hook. & Arn. Flowers large for the size of the plant. —Common in sandy places; often in colonies.

3. Scrophularia L. Figwort.

1. *Scrophularia californica* Cham. California Figwort. Tall, erect leafy plant with dull red or brown flowers.—Lava trenches, caved-in galleries, etc. Common about the cave area in the vicinity of Indian Well, and at the Stronghold.

4. Pentstemon Mitch.

Flowers blue or purple; leaves entire.
Leaves bright green, smooth.
Stems matted; anthers woolly ..... 1. *P. Menziesii* var.
Stems taller, erect; anthers not woolly.
Flowers purplish, broad, an inch or more long ..... 2. *P. speciosus.*
Flowers bluish, narrow, less than an inch long ..... 3. *P. gracilentus.*
Leaves ashy-gray, rough but not hairy.
Basal leaves with long slender petioles ..... 4. *P. cinereus.*
Basal leaves few and inconspicuous ..... 5. *P. laetus* var.
Flowers yellowish, leaves toothed ..... 6. *P. deustus.*

1. *Pentstemon Menziesii Davidsoni* (Greene) Piper. Davidson Pentstemon. A prostrate plant with a woody base, small roundish leathery entire leaves and many attractive purple flowers.—On rock ledges about the base of Cinder Cone Butte; abundant southward in the Medicine Lake region.

2. *Penstemon speciosus* Dougl. Easily recognized by the large purplish flowers and thickish smooth leaves.—To be found occasionally in sandy places in ponderosa pine woods; Upper Ice Cave, Eaglenest Butte, Mammoth Crater, etc.

3. *Pentstemon gracilentus* Gray. While not detected within our limits, this species may be expected in the southwest corner, since it is common along the Medicine Lake road just without the monument. The clusters of small blue flowers terminate the narrow clump of strict stems which are thickly surrounded by long petioled leaves.

4. *Pentstemon cinereus* Piper. Ashy Pentstemon. A plant with many stems which form clumps about a foot high, the leaves mostly basal.—The most abundant species in the monument.

5. *Pentstemon laetus sagittatus* Keck.—Common and resembling the last, but differing in its larger flowers and absence of conspicuous basal leaves.

6. *Pentstemon deustus* Dougl. Rock Pentstemon. This very abundant species thrives in the most inhospitable situations, rock ledges, clefts, etc. The only species within our limits having toothed leaves and yellow flowers.

5. Castilleja Mutis.

Flowers and foliage mixed with red.
  Stems very tall; leaves narrow, entire ..... 1. *C. linariaefolia.*
  Stems lower; leaves broader, cleft ..... 2. *C. pinetorum.*
Flowers and foliage white ..... 3. *C. pilosa.*

1. *Castilleja linariaefolia* Benth. Desert Paintbrush. This striking plant is rather infrequently seen, its red heads topping the sagebrush, as along the Lyons road above Skull Cave.

2. *Castilleja pinetorum* Fernald. Pine Paintbrush. Characteristic of the ponderosa pine areas.—Common along the south border and on the easterly slopes of the cinder cones.

3. *Castilleja pilosa* (S. Wats.) Rydb. White Paintbrush. Usually in sagebrush; Upper Ice Cave, Ruby Hill, etc.

36. *Rubiaceae.* Madder Family.

1. Galium L. Bedstraw.

1. *Galium aparine* L. Bedstraw. A plant with slender rough square stems, whorled leaves and small white flowers; the stems often supported by bushes.—Common: Stronghold, Sheepherder's road, Sconchin Butte, etc.

37. *Caprifoliaceae.* Honeysuckle Family.

Flowers small, white, wheel-shaped, in large flat-topped clusters; berry small, blue ..... 1. *Sambucus.*
Flowers larger, pinkish, tubular; berries white ..... 2. *Symphoricarpus.*

1. Sambucus L. Elderberry.

1. *Sambucus caerulea* Raf. Blue Elderberry. Widely distributed but not abundant.—A number of bushes at Indian Well and in broken rocks on the north boundary opposite the Stronghold.

2. Symphoricarpos L.

1. *Symphoricarpos rotundifolius* Gray. Long-flowered Snowberry. Infrequent in the pine area; Caldwell Butte and Eaglenest Butte.

38. *Valerianaceae.* Valerian Family.

1. *Plectritis macrocera* Torr. & Gray. Small smooth plants with opposite rather fleshy leaves and clusters of minute flowers.—Common throughout the area.

39. *Compositae.* Sunflower Family.

Heads with both ray and disk flowers (radiate).
- Herbs.
  - Rays white.
    - Heads clustered — 1. *Achillea.*
    - Heads solitary.
      - Anthers and style purple — 2. *Blepharipappus.*
      - Anthers and style yellow — 3. *Layia.*
  - Rays blue or purple.
    - Bracts of the involcure in several overlapping series — 4. *Aster.*
    - Bracts in 1 or 2 series — 5. *Erigeron.*
  - Rays yellow.
    - Pappus with numerous slender bristles.
      - Heads many, small; plant tall — 6. *Solidago.*
      - Heads few, larger; plant lower — 7. *Senecio.*
    - Pappus with few scales or awns or none.
      - Bracts of the involucre wrapped about an outer achene.
        - Outer achenes with their bracts having narrow backs — 8. *Madia.*
        - Outer achenes with their bracts having broad rounded backs — 9. *Hemizonella.*
      - Bracts not enfolding the achenes.
        - Disk-flowers intermingling with conspicuous scales or bracts.
          - Pappus present, of awns or scales.
            - Perennial; plant large — 10. *Wyethia.*
            - Annual; plant small — 11. *Baeria.*
          - Pappus none; leaves broad — 12. *Balsamorrhiza.*
        - Disk-flowers without intervening scales or bracts (naked).
          - Plant woolly — 13. *Eriophyllum.*
          - Plant viscid — 14. *Hulsea.*
- Shrub — 15. *Aplopappus.*

Heads without ray-flowers (discoid).
- Shrubs.
  - Heads with 4 flowers — 16. *Tetradymia.*
  - Heads with 5-9 flowers — 17. *Artemisia.*
  - Heads with numerous flowers — 18. *Chrysothamnus.*
- Herbs.
  - Heads yellow — 5. *Erigeron.*
  - Heads white or pink.
    - Plant woolly.
      - Leaves spiny-toothed — 19. *Cirsium.*
      - Leaves without spines.
        - Pappus of slender bristles — 20. *Antennaria.*
        - Pappus of flat white scales — 21. *Chaenactis.*
    - Plants not woolly.
      - Perennial; plant large — 22. *Eupatorium.*
      - Annual; plant very small — 23. *Dimeresia.*

Heads with only strap-shaped flowers. Chicory Tribe.
- Rays pink — 24. *Stephanomeria.*
- Rays yellow or white.
  - Heads solitary; stems simple from a leafy base.
    - Pappus of scales or feathery — 25. *Microseris.*
    - Pappus of simple bristles or hairs — 26. *Agoseris.*
  - Heads several; stems branched.
    - Leaves deeply lobed — 27. *Crepis.*
    - Leaves entire or toothed — 28. *Hieracium.*

1. ACHILLEA L. Yarrow.

1. *Achillea lanulosa* Nutt. Plants about a foot high with clustered erect stems, narrowly finely cut leaves and flat-topped head-clusters.—Not abundant in our area: Indian Well.

2. BLEPHARIPAPPUS Hook.

1. *Blepharipappus scaber* Hook. Small erect annuals, more or less branched above, with very narrow leaves and showy white flowers with purple anthers and styles.—Not common in our limits: sagebrush flats and ridges; top of Gillem Bluff.

3. LAYIA Hook.

1. *Layia glandulosa* (Hook.) H. & A. Tarweed. Low, simple, or branched, sticky, ray-flowers pure white, showy.—Common in flat low areas.

4. ASTER L.

1. *Aster shastensis* Gray. Shasta Aster. The several to many stiff stems usually about a foot high, forming a rather dense clump.—Sandy places: Caldwell, Bearpaw, and Juniper Buttes.

5. ERIGERON L. Fleabane.

Heads with ray-flowers; stems erect ..... 1. *E. concinnus.*
Heads without evident ray-flowers; mat plants.
  Flowering stems without leaves; pubescence of stiff hairs ..... 2. *E. Austinae.*
  Flowering stems sparingly leafy; pubescence of soft hairs ..... 3. *E. linearis* var.

1. *Erigeron concinnus* Torr. & Gray. The many slender stems branched from the base; leaves linear; heads with many narrow blue rays.—Common throughout the region. Caldwell and Sconchin Buttes.

2. *Erigeron Austinae* Greene. Austin Fleabane. Vicinity of Goosenest Butte.

3. *Erigeron linearis elegantulus* J. T. Howell. Narrow-leaved Fleabane. Upper Ice Cave area.

6. SOLIDAGO L. Goldenrod.

Solidago occidentalis Nutt. Western Goldenrod. Stems simple, 3-5 feet high, branched at the top, terminated by flat-topped clusters of small flower-heads.

7. SENECIO L. Ragwort.

1. *Senecio Howellii* Greene. Howell Ragwort. The erect stems a foot or less high, the roundish leaves mostly in basal tufts, the whole plant more or less woolly.—Rather frequent: Indian Well, Three Sisters.

8. MADIA Mol. Tarweed.

1. *Madia gracilis* (Smith) Keck & Clausen. Slender Tarweed. Stems slender with long narrow leaves; heads with inconspicuous rays and solitary disk-flowers.—Infrequent: southerly slope of Hippo Butte.

9. HEMIZONELLA Gray.

1. *Hemizonella minima* Gray. Little Tarweed. A very small plant with rough herbage and minute flower-heads.—Bearpaw Butte.

10. WYETHIA Nutt.

1. *Wyethia mollis* Gray. Woolly-leaf Sunflower. The several stems 1-3 feet high, bearing one or more large heads; the large broad leaves white-woolly, growing in a basal tuft.—Pine woods on the western border, and at Bearpaw Butte.

11. BAERIA F. & M. Gold-fields.

Baeria chrysostoma F. & M. A low annual with flower-heads large for the size of the plant; pubescence consisting of loose bunches of wool.—Sagebrush flats: top of Gillem Bluff.

12. BALSAMORRHIZA Hook. Balsam Root.

1. *Balsamorrhiza sagittata* Nutt. Arrow-leaf Balsam Root. Stems 1-2 feet high, bearing usually a single large head, the yellow rays about 2 inches long.—Widely distributed: Indian Well, Skull Cave, Bearpaw Butte, Petroglyph Bluff.

13. ERIOPHYLLUM Lag.

1. *Eriophyllum lanatum* (Pursh) Forbes. A woolly plant with many leafy stems and numerous heads with golden-yellow rays. A very variable species. Two forms of quite dissimilar appearance are found in our area: Variety *achillaeoides* (DC.) Jepson has tall erect stems and pinnately parted or cleft leaves; variety *integrifolium* (Hook.) Smiley is a lower, more or less matted plant with mostly narrow entire leaves.

14. HULSEA Torr. & Gray.

1. *Hulsea nana* Gray. Dwarf Hulsea. A low viscid plant with rather large heads, characteristic of cinder slopes.—Rare in our area: Cinder Butte.

15. APLOPAPPUS Endl.

1. *Aplopappus Bloomeri angustatus* Gray. Bloomer Rabbit-brush. Low spreading shrub with abundant heads with bright-yellow rays; leaves very narrow.—Not common: Caldwell and Bearpaw Buttes.

16. TETRADYMIA DC.

1. *Tetradymia canescens* DC. A white-woolly bush with narrow crowded leaves and flat-topped clusters of few-flowered heads.—Throughout the area scattered among sagebrush, etc. More abundant about the cinder cones: Hippo, Sconchin, and Caldwell Buttes.

17. ARTEMISIA L.

1. *Artemisia tridentata* Nutt. Common Sagebrush. Large, much-branched shrub, silvery-gray throughout, highly aromatic; leaves 3-toothed at apex; flower sprays 6-18 inches long.—Everywhere; dominant over considerable areas.

18. CHRYSOTHAMNUS Nutt. Rabbit Brush.

Leaves gray-green; stems woolly ..... 1. *C. nauseosus* var.
Leaves bright-green; stems smooth ..... 2. *C. viscidiflorus.*

1. *Chrysothamnus nauseosus speciosus* (Nutt.) Hall. Gray Rabbit Brush.

This tall shrub usually occurs in the lower flat areas in more or less alkaline soil.—Common along the lower Lyons road.

2. *Chrysothamnus viscidiflorus* Nutt. Green Rabbit Brush. A rounded bush with green leaves and shiny-white stems.—Throughout the area, usually on higher ground than the last.

C. viscidiflorus latifolius Greene is a form with broader leaves.

C. viscidiflorus puberula D. C. Eaton is a less common form with very narrow leaves seen only occasionally within our limits:—Caldwell Butte crater.

19. Cirsium Scop. Thistle.

1. *Cirsium* sp. Of doubtful identity. A few dried specimens seen among mahogany bushes southwest of Indian Well.

20. Antennaria Gaertn.

Low matted more or less woolly herbs, the flower-heads with papery involucral bracts.

Stems sparsely leafy above----------1. *A. rosea.*
Stems densely leafy above----------2. *A. Geyeri.*

1. *Antennaria rosea* (D. C. Eaton) Greene. Bearpaw Cave.
2. *Antennaria Geyeri* Gray. Caldwell Butte.

21. Chaenactis DC.

1. *Chaenactis Douglasii* Hook. & Arn. About a foot high, leaves cut into small lobes; heads usually several, forming a loose flat-topped cluster.

22. Eupatorium L.

1. *Eupatorium occidentale* Hook. Western Eupatorium. The strict erect stems sometimes somewhat woody, over a foot high; leaves ovate, toothed; heads pink.—Sparingly abundant: Devil's Homestead.

23. Dimeresia Gray.

1. *Dimeresia Howellii* Gray. A diminutive annual with a cluster of very small flowers.—Exposed slopes of cinder cones: Caldwell, Sconchin, Eaglenest Buttes and the talus slope of Tule Lake Peninsula.

24. Stephanomeria Nutt.

Perennial; stem much branched----------1. *S. tenuifolia*
Annual; stem mostly simple----------2. *S. virgata.*

1. *Stephanomeria tenuifolia* (Torr.) Hall. Many slender branches from a woody base.—Common around Caldwell and Hippo Buttes.

2. *Stephanomeria virgata* Benth. The usually simple stem strict, 2-4 feet high.—Less frequent than the other species. Plentiful about the easterly base of Caldwell Butte.

25. MICROSERIS Don.

Plants resembling dandelions.

Leaves very narrow; stems branched ..... 1. *M. nutans*
Leaves broader; stems simple ..... 2. *M. troximoides.*

1. *Microseris nutans* (Geyer) Schulz. Bearpaw Butte.
2. *Microseris troximoides* Gray. Indian Well.

26. AGROSERIS Raf. False Dandelion.

1. *Agroseris alpestris* Greene. Throughout the area.

27. CREPIS L. Hawksbeard.

Tall, many-stemmed plant ..... 1. *C. acuminata.*
Lower, few-stemmed plant ..... 2. *C. occidentalis.*

1. *Crepis acuminata* Nutt. Tall Hawksbeard. Usually about 15 inches high; leaves mostly basal; the many heads showy.—Very common everywhere. A less common form is *C. acuminata intermedia* (Gray) Jepson, differing from the type in being more or less woolly.

2. *Crepis occidentalis* Nutt. Western Hawksbeard. A lower, less common plant than the last.

28. HIERACIUM L. Hawkweed.

1. *Hieracium Scouleri* Hook. Scouler Hawkweed. Stems simple to few, about a foot high, rays bright yellow; herbage hairy.—Rather rare: Bearpaw Butte.

DUDLEY HERBARIUM,
STANFORD UNIVERSITY,
CALIFORNIA.

INDEX

Abies 344
Achillea 364
Agastache 360
Agropyron 346
Agroseris 367
Amelanchier 353
Amsinckia 359
Antennaria 366
Aplopappus 365
Apocynum 357
Arabis 352
Arceuthobium 348
Arctostaphylos 356
Arenaria 350
Artemisia 365
Aster 364
Astragalus 354
Atriplex 349

Baeria 365
Balsamorrhiza 365
Blepharipappus 364
Bromus 345

Calochortus 347
Castanopsis 347
Castilleja 362
Ceanothus 355
Cercocarpus 353
Chaenactis 366
Chamaebatiaria 354
Chenopodium 349
Chrysothamnus 365
Cirsium 366
Collinsia 361
Collomia 358
Crepis 367
Cryptantha 359
Cycladenia 357
Cystopteris 344

Delphinium 350
Descurainia 351
Dimeresia 366

Elymus 346
Epilobium 356
Erigeron 364
Eriophyllum 365
Erodium 355
Erysimum 351
Eschscholtzia 351
Eriogonum 348
Eupatorium 366

Festuca 346
Frasera 356
Fritillaria 347

Galium 362
Gayophytum 356
Geum 354
Gilia 358
Godetia 356
Grayia 349
Gymnogramme 344

Hackelia 359
Hemizonella 364
Heuchera 352
Hieracium 367
Holodiscus 353
Hordeum 346
Hulsea 365

Juncus 346
Juniperus 345

Koeleria 345

Lappula 359
Layia 364
Leptodactylon 357
Leucocrinum 347
Lewisia 350
Libocedrus 344
Linum 355
Lithophragma 352
Lomatium 356
Lupinus 354

Madia 364
Marrubium 360
Mentzelia 355
Microseris 367
Mimulus 361
Monardella 360
Montia 349
Myosurus 350

Nama 358
Nasturtium 352
Nicotiana 360

Oenothera 356
Parrya 352
Pentstemon 361
Phacelia 358
Phleum 345
Phlox 357
Phoradendron 348
Pinus 344
Plagiobothrys 359
Poa 346
Polemonium 357
Polygonum 349
Populus 347
Potentilla 354
Prunus 353
Purshia 353

Ranunculus 350
Ribes 352
Rosa 354
Rumex 349

Salix 347
Salsola 349
Salvia 360
Sambucus 362
Scrophularia 361
Scutellaria 360
Senecio 364
Silene 350
Sisymbrium 351
Sitanion 346
Smelowskia 352
Solanum 360
Solidago 364
Stephanomeria 366
Stipa 345
Symphoricarpos 362
Tetradymia 365
Thelypodium 352

Urtica 348

Vicia 354
Viola 355

Wyethia 365

Zygodenus 347

Flora of Muskogee County, Oklahoma[1]

Elbert L. Little, Jr.

This flora of Muskogee County, Oklahoma, which lists 829 species of vascular plants, is one of four papers forming a botanical survey of Muskogee County, condensed from the author's unpublished study (1929-30). Lists of 94 species of bryophytes and 11 species of pteridophytes of Muskogee County have been published (1933, 1936), and the vegetation of this county will be the subject of another article.

Muskogee County, of which the city of Muskogee is the county seat, is located in northeastern Oklahoma within the area bounded by 35° and 36° north latitude and 95° and 96° west longitude. It covers an irregular, gerrymandered area of 826 square miles. Physiographically, it is partly in the Ozark region and partly in the prairie plains region. The Arkansas River, Oklahoma's largest stream, passes through the county, and the Canadian River, its largest tributary, forms a portion of the southern boundary of the county. As to its vegetation, Muskogee County is in the transition zone between the deciduous forest on the east and the grassland on the west and has both climax types.

Previous Collections

Apparently this is the first county flora in Oklahoma to be published, although more or less complete collections have been made by botanists at various places in the State, especially at educational centers. Early studies on the flora of Oklahoma have been reviewed by Jeffs and Little (1930).

The first botanist to visit the area which is now Muskogee County was Thomas Nuttall (1821, 1834, Palmer 1927), who in July-September 1819 collected in the eastern part of Oklahoma. His route through Muskogee County was by boat up the Arkansas River to the mouth of the Verdigris River and westward across the prairie of the northern part of the county. He collected specimens of a number of species new to science and described the vegetation along his course.

In 1820 the two parties of Major Stephen H. Long's expedition to the Rocky Mountains passed east across Oklahoma along Muskogee County, one on the Canadian River and the other on the Arkansas River. Lists of the plants collected, a few of which may have been from this vicinity, were published by James (1823, 1825) and Torrey (1828).

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1 This study was made during the years 1925 to 1929. The author is now a member of the research staff of the Southwestern Forest and Range Experiment Station, which is maintained at Tucson, Ariz., by the Forest Service, United States Department of Agriculture, in cooperation with the University of Arizona.

A few collections were made in later years at Muskogee. M. A. Carleton collected specimens of 36 species of flowering plants including 10 species of Carex at Muskogee in April 1891 while on a collecting trip in the northern part of Oklahoma. The list was published by Holzinger (1892), who made most of the determinations.

Specimens of 9 species collected by J. Schenck at Muskogee in May 1894 were seen in the Herbarium of the Field Museum of Natural History. Dr. Ezra Brainerd distributed in his "Viola of North America" specimens of 6 species of Viola which he collected in Muskogee County in March-April 1908 and April 1910. These miscellaneous specimens and published records total 56 species from Muskogee County, of which 16 are not represented also in the author's collections.

Summary of Species

Field studies by the author extended from 1925 to 1929, but most of the collections were made from March to October 1927. Specimens were collected in about 145 sections distributed in all of the 30 townships and parts of townships in the county. From these about 2,300 were mounted, and this entire collection from the author's herbarium has been deposited in the Herbarium of the University of Oklahoma. Determinations of most specimens were made by the writer in 1928 at the Herbarium of the Field Museum of Natural History, in Chicago, Ill. International Rules of Nomenclature were followed.

The list of vascular plants contains 829 species and 13 additional varieties which are considered by some botanists as of specific rank. There are 11 species of pteridophytes, 2 species of gymnosperms, and 816 species of angiosperms. Four hundred twenty-four genera and 104 families are included, but 27 families are represented by a single species each. A few species of this collection which had not been found previously in Oklahoma were included in the State list by Jeffs and Little (1930).

Compositae, Gramineae, and Leguminosae, the three largest families in number of species found in Muskogee County and the characteristic families of the prairie, together contain 289 species or 34.9 percent of the total. The ten largest families, with numbers of species are: Compositae, 124 species; Gramineae, 98; Leguminosae, 67; Cyperaceae, 39; Euphorbiaceae, Labiatae, and Scrophulariaceae, 23 each; Rosaceae, 21; Umbelliferae, 17; and Polygonaceae, 16. Genera represented by the greatest number of species in Muskogee County are: Panicum, 21 species; Carex, 13; Juncus, Polygonum, and Euphorbia, 11 each; and Cyperus and Quercus, 10 each.

Relationships of the Flora

Floristically, Muskogee County is located in the Atlantic North American region in the transition area between the Ozark district of the Appalachian province and the prairie province. Floras of both the oak-hickory forest and the tall-grass prairie are well represented.

The species of Muskogee County have been grouped according to their

ranges, as given in current manuals, to show relationships and origin of the flora. Any such grouping is more or less arbitrary, as many of the species seem to fall into more or less natural units and others do not. In the classification used, only the ranges of species within temperate North America have been considered, and ranges of varieties have been omitted.

The classification of the 829 species of Muskogee County together with the number of species and percentage of each group follows. The letter abbreviations used for these groups in the list of species are given in parenthesis.

Species of wide range in North America (including cosmopolitan species), 82 species or 9.9 percent (A)

Species of wide range across southern United States, 20 species or 2.4 percent (S)

Species of eastern North America (Atlantic North American region), 623 species or 75.2 percent.

- Species of wide range in eastern North America, 308 species or 37.2 percent (E)
- Species of southeastern United States, 172 species or 20.8 percent (SE)
- Species of wide range in interior of United States (prairie states, etc.), 93 species or 11.2 percent (P)
- Species restricted to the area from Missouri and Kansas to Louisiana and Texas or slightly beyond, 50 species or 6.0 percent (MT)

Species of western North America (Pacific North American region), 30 species or 3.6 percent

- Species of wide range in western North America, 16 species or 1.9 percent (W)
- Species of southwestern United States, 14 species or 1.7 percent (SW)

Introduced species, 74 species or 8.9 percent (I)

These groups will be explained with examples. Species of wide range in North America include cosmopolitan species and those which occur nearly throughout the United States or on both Atlantic and Pacific coasts. Examples are: *Typha latifolia*, a cosmopolitan species; *Geranium carolinianum*, which ranges from Newfoundland and Ontario to British Columbia and Alaska and south to Florida, California, and Mexico; and *Erigeron philadelphicus*, which occurs from Labrador to British Columbia south to Florida and California.

Of the small group of species with wide range in southern United States, *Scirpus carinatus*, which occurs from Tennessee and Alabama to Oklahoma, Texas, and California, and *Cissus incisa*, which extends from Florida to Missouri, Kansas, Texas, and Arizona, may be considered representative.

The species of eastern North America occurring mostly or entirely within the Atlantic North American floristic region are divided into four groups. The largest, which includes species of wide range in eastern North America, corresponds with the limits of this floristic region. These species typically occur from New England or Nova Scotia west to Minnesota and south to Florida and Texas, such as do *Juniperus virginiana* and *Ulmus americana*. Not all the species grouped here extend south to the Gulf States, however.

Species of southeastern United States have a typical range from New Jersey or southern New England on the Atlantic coast west along the Ohio Valley to Missouri and Kansas and south to Florida and Texas, although

many of the species do not extend so far north. Examples are *Pinus echinata, Agave virginica, Passiflora incarnata, Ilex decidua, Diospyros virginiana,* and *Viburnum rufidulum.*

The group, plants of wide range in the interior of the United States, chiefly the prairie States, is a loose one and contains some western species. It includes such species as *Sisyrinchium campestre,* which occurs from Wisconsin to Missouri and Louisiana west to Manitoba, North Dakota, Kansas, and New Mexico; and *Silphium laciniatum,* which extends from Ohio and Michigan to North Dakota and south to Alabama, Louisiana, and Texas.

Fifty species are restricted to the area from Missouri and Kansas to Louisiana and Texas or slightly beyond. A few of these occur in only two or three States. This relatively uniform area is poor in endemic species, and none of the known species of Muskogee County is confined to Oklahoma. Some of the species of this group are commonly represented, while a few occur but sparingly. These fifty species of restricted distribution are:

Sagittaria ambigua
Triodia stricta
Tradescantia ernestiana
Yucca louisianensis
Carya buckleyi
Maclura pomifera
Eriogonum longifolium
Stellaria nuttallii
Corydalis crystallina
Selenia aurea
Sedum nuttallianum
Saxifraga texana
Crataegus bellica
Crataegus dallasiana
Crataegus trianthophora
Rosa foliosa
Rhynchosia latifolia
Oxalis interior
Euphorbia malaca
Callirhoe digitata
Viola lovelliana
Viola missouriensis
Ammoselinum butleri
Chaerophyllum texanum
Ptilimnium nuttallii
Cynosciadium pinnatum
Trepocarpus aethusae
Sabatia campestris
Verbena pumila
Monarda russelliana
Physalis missouriensis
Solanum torreyi
Collinsia violacea
Gerardia heterophylla
Pentstemon tubiflorus
Ruellia pedunculata
Valerianella longiflora
Valerianella nuttallii
Valerianella stenocarpa
Ambrosia bidentata
Aplopappus ciliatus
Boltonia latisquama
Chrysopsis pilosa
Iva angustifolia
Rudbeckia amplexicaulis
Rudbeckia grandiflora
Senecio imparipinnatus
Solidago gymnospermoides
Solidago radula
Vernonia crinita

The influence of Nuttall's early field work in Oklahoma and Arkansas is shown by the fact that fifteen of these fifty species bear Nuttall's name as author and four additional ones were named in his honor.

Species of western North America are typical of the Pacific North American floristic region, which extends from the Great Plains to the Pacific. The group, species of wide range in western North America, includes species which reach the limits of this region. Among these are *Polanisia trachysperma,* which ranges from Iowa, Missouri, and Texas west to British Columbia and California, and *Helianthus petiolaris,* which occurs from Manitoba, Minnesota, Missouri, and Texas west to British Columbia and California.

The species of southwestern United States form a miscellaneous group typically ranging from Missouri and Texas to Arizona and in some cases to Mexico also. Examples are: *Sapindus drummondii, Solanum elaeagnifolium,* and *Centaurea americana.*

The introduced species are those which are not native in Muskogee County, although they may grow naturally elsewhere in North America, but which have been brought in as a result of man's activities and have become established. They include some of the common weeds, such as *Setaria lutescens, Amaranthus retroflexus, Capsella bursa-pastoris,* and *Taraxacum vulgare.* Although this area has been settled a shorter time than surrounding States, one species out of eleven, or 8.9 percent, has been introduced.

Thus, the flora of Muskogee County is clearly eastern in its relationships. While 75.2 percent of the species are classed as eastern in range, only 3.6 percent are listed as western. However, some of the species of the interior of the United States might have been grouped as western instead of eastern. The line separating eastern and western floras is between prairie and plain rather than between eastern deciduous forest and grassland, and the tall-grass flora of Muskogee County is clearly eastern. As the eastern border of the short-grass vegetation is some distance west of this county, it is to be expected that western species be poorly represented in Muskogee County.

Species at or near Limits

In any area some of the species approach the limits of their range in one direction. Because of its position in the transition zone between deciduous forest and prairie, Muskogee County has greater than average number of species at or near their limits. These comprise three groups: eastern forest species near their western or southwestern limits; southeastern forest species near their western limits; and western species near their eastern limits. In most cases the flora of surrounding counties is not sufficiently known for exact ranges to be determined.

The largest group, that of eastern species, includes the more mesophytic tree and forest undergrowth species that gradually drop out westward in the forest-prairie transition zone. A partial list of the eastern and northeastern species which are at or very near the western borders of their ranges in Muskogee County follows:

Silene stellata
Anemone virginiana
Isopyrum biternatum
Podophyllum peltatum
Benzoin aestivale
Sassafras variifolium
Arabis canadensis
Iodanthus pinnatifidus
Baptisia leucantha
Hibiscus lasiocarpa
Viola emarginata
Viola sororia
Cryptotaenia canadensis
Taenidia integerrima
Nyssa sylvatica
Sabatia angularis
Asclepias quadrifolia
Phlox divaricata
Pycnanthemum flexuosum
Scutellaria versicolor
Buchnera americana
Triosteum aurantiacum
Lepachys pinnata
Polymnia uvedalia

Of special interest is the disjunct occurrence of *Acer saccharum*. This species is at its western limit of its continuous range in the maple-oak forest on limestone soils of eastern Muskogee County but is represented by disjunct patches 175 miles westward in four canyons in Caddo and Canadian counties, west central Oklahoma. The islands in west central Oklahoma are regarded as relicts from a period of more humid climate when the deciduous forest probably extended farther west.

The Ozark Plateau of northeastern Oklahoma and the Ouachita Mountains contain a number of mesophytic eastern species which do not extend west even to Muskogee County. In Cherokee County, which borders Muskogee County on the northeast, certain eastern species, especially trees and shrubs, are commonly represented at their western limits. In small collections in Cherokee County within 15 miles of the Muskogee County line, the author collected specimens of the following species of probably a much larger group not found in the latter county:

Cheilanthes alabamensis	*Dicentra cucullaria*
Ostrya virginiana	*Geranium maculatum*
Castanea ozarkensis	*Acer rubrum*
Quercus alba	*Tilia floridana*
Trillium viridescens	*Circaea lutetiana*
Sanguinaria canadensis	*Vaccinium melanocarpum*

Ferns of two species, *Adiantum pedatum* and *Polystichum acrostichoides*, were collected within two miles of the county line but are not known to occur in Muskogee County.

A few species of southeastern range apparently near the western borders of their ranges in Muskogee County. These include, among others: *Pinus echinata, Cladrastis lutea, Robinia pseudo-acacia, Tephrosia onobrychoides, Berchemia scandens, Viola lovelliana, Passiflora incarnata,* and *Vaccinium arboreum.*

Some of the species of western range in the Pacific North American region are near the eastern borders of their ranges in Muskogee County. These include: *Commandra pallida, Mentzelia oligosperma,* and *Polanisia trachysperma.*

Several of the western species are known in Muskogee County only from the sand flood plain of the Canadian River, where they obviously have migrated eastward along the sand deposits. These western species, which occur in similar habitats farther west in the State, include: *Fuirena simplex, Indigofera leptosepala, Tamarix gallica* (adventive from the west), *Eustoma russellianum, Heliotropium convulaceum, Aphanostephus skirrobasis, Baccharis salicina,* and *Grindelia squarrosa.* Two additional species, *Parosela lanata* and *Aplopappus divaricatus,* were found on sand along both the Arkansas and Canadian rivers.

Conspicuous by its absence is *Callirhoe involucrata,* commonly represented in prairies of central Oklahoma but apparently not extending eastward to Muskogee County.

Biological Spectrum of Muskogee County

A biological spectrum of the 818 species of seed plants in Muskogee County has been prepared according to Raunkiaer's (1934) classification of life forms to show the characterization of the climate by the flora. The life forms of herbaceous species are compiled mainly from descriptions in manuals, but those of woody species are based upon size attained in this county.

A few life forms are poorly represented. There are no trees in this county commonly reaching the size of megaphanerophytes (above 30 meters in height). The only species of stem succulents is *Opuntia humifusa,* the only species of epiphytic phanerophytes is *Phoradendron flavescens,* and the only species of chamaephytes is *Ascyrum hypericoides.*

Raunkiaer's revised normal spectrum for the earth and the spectrum of Muskogee County are tabulated below. The abbreviations in parenthesis are used in the list of species.

	Raunkiaer's revised normal spectrum percent.	Muskogee County, percent.
Phanerophytes	46	13.7
Stem succulents (S)	2	.1
Epiphytes (E)	3	.1
Megaphanerophytes aand mesophanerophytes (MM)	8	4.6
Microphanerophytes (M)	18	5.6
Nanophanerophytes (N)	15	3.3
Chamaephytes (Ch)	9	.1
Hemicryptophytes (H)	26	50.7
Cryptophytes	6	5.1
Geophytes (G)	4	3.7
Helophytes and hydrophytes (HH)	2	1.4
Therophytes (Th)	13	30.4

The increased proportion of herbaceous species in Muskogee County is clearly shown by the high percentages of hemicryptophytes and therophytes and by the correspondingly low percentages of phanerophytes. Only one species in seven is woody, and the rest are herbaceous. Because of the great increase of hemicryptophytes over the normal spectrum, as is typical in the temperate zone, the climate of Muskogee County may be said to be hemicryptophytic.

Raunkiaer's (1934) quotients based upon relative numbers of cryptogam species for characterizing plant climates have been computed from the author's lists of the pteridophytes, mosses, and liverworts of Muskogee County. The pteridophyte quotient of Muskogee County, based upon the actual number of species of pteridophytes in proportion to the number the county should have for its number of phanerogam species on the basis of species of the world, is .34, or about one-third of average. Similarly, the moss quotient of the county is 1.06, and the liverwort quotient is .60. According to these quotients, the climate of Muskogee County is unfavorable for pteridophytes, average for mosses, and below average for liverworts.

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The author is greatly indebted to the following persons, to whom he wishes to express his appreciation for their services: Mr. and Mrs. E. L. Little, for assistance in collecting specimens; the late Dr. D. C. Davies, formerly acting director of the Field Museum of Natural History, for the privilege of using the Herbarium of the Field Museum in determining specimens; Dr. H. I. Featherly, of the Oklahoma Agricultural and Mechanical College, for examining the collection of Gramineae and making determinations of a few specimens; Mr. E. J. Palmer, of the Arnold Arboretum, for determining the specimens of Crataegus; and for suggestions, to Professor H. C. Cowles, chairman emeritus of the department of botany of the University of Chicago, under whose direction this study was completed.

List of Species

In the list of species the two abbreviations after the species are, first, Raunkiaer's life form of the seed plants, and, second, range or geographic distribution. The 16 species not in the author's collection are indicated by name of the collector and the abbreviation "Herb. Field," if a specimen from Muskogee County was seen in the Herbarium of the Field Museum of Natural History, or by reference to literature cited, if the record was found in a publication.

PTERIDOPHYTA

Polypodiaceae

Asplenium platyneuron (L.) Oakes. E.
Asplenium resiliens Kunze. SE.
Camptosorus rhizophyllus (L.) Link. E.
Cheilanthes lanosa (Michx.) Watt. SE.
Filix fragilis (L.) Gilib. A.
Notholaena dealbata (Pursh) Kunze. SW.
Pellaea atropurpurea (L.) Link. A.
Polypodium polypodioides (L.) Hitchc. SE.
Woodsia obtusa (Spreng.) Torr. E.

Ophioglossaceae

Ophioglossum engelmanni Prantl. S.

Equisetaceae

Equisetum praealtum Raf. A.

SPERMATOPHYTA

GYMNOSPERMAE

Pinaceae

Juniperus virginiana L. M; E.
Pinus echinata Mill. MM; SE.

ANGIOSPERMAE

MONOCOTYLEDONEAE

Typhaceae

Typha angustifolia L. HH; A.
Typha latifolia L. HH; A.

Alismaceae

Sagittaria ambigua J. G. Smith. HH; MT.
Sagittaria latifolia Willd. HH; E.

Gramineae

Agrostis alba L. H; I.
Agrostis hyemalis (Walt.) BSP. Th; A.
Alopecurus geniculatus L. var. *aristulatus* Munro. Holzinger (1892). H; A.
Andropogon furcatus Muhl. H; E.
Andropogon hallii Hack. H; P.
Andropogon saccharoides Sw. H; S.
Andropogon scoparius Michx. H; E.
Andropogon ternarius Michx. H; SE.
Aristida curtissii (Gray) Nash. Th; P.
Aristida dichotoma Michx. Th; E.
Aristida intermedia Scribn. & Ball. Th; P.
Aristida longespica Poir. Th; SE.
Aristida oligantha Michx. Th; SE.
Arundinaria tecta (Walt.) Muhl. M; SE.
Avena sativa L. Th; I.

Bouteloua curtipendula (Michx.) Torr. H; E.
Bouteloua hirsuta Lag. H; P.
Bromus ciliatus L. H; E.
Bromus commutatus Schrad. Th; I.
Bromus purgans L. H; E.
Bromus secalinus L. Th; I.
Cenchrus pauciflorus Benth. Th; A.
Chloris verticillata Nutt. H; P.
Cinna arundinacea L. H; E.
Cynodon dactylon (L.) Pers. H; I.
Danthonia spicata (L.) Beauv. H; E.
Digitaria filiformis (L.) Koel. Th; E.
Digitaria ischaemum (Schreb.) Muhl. Th; I.
Digitaria sanguinalis (L.) Scop. Th; I.
Echinochloa crusgalli (L.) Beauv. Th; I.
Eleusine indica (L.) Gaertn. Th; I.
Elymus villosus Muhl. H; E.
Elymus virginicus L. H; E.
Elymus virginicus var. *australis* (Scribn. & Ball) Hitchc.
Elymus virginicus var. *glabriflorus* (Vasey) Bush.
Eragrostis capillaris (L.) Nees. Th; SE.
Eragrostis cilianensis (All.) Link. Th; I.
Eragrostis pectinacea (Michx.) Nees. H; E.
Eragrostis pilosa (L.) Beauv. Th; I.
Eragrostis reptans (Michx.) Nees. Th;P.
Eragrostis secundiflora Presl. H; P.
Eragrostis trichodes (Nutt.) Nash. H; P.
Festuca octoflora Walt. Th; A.
Festuca shortii Kunth. H; SE.
Hordeum pusillum Nutt. Th; P.
Hystrix patula Moench. H; E.
Koeleria cristata (L.) Pers. Th; A.
Leersia virginica Willd. H; E.
Leptochloa fascicularis (Lam.) Gray. Th; P.
Leptochloa filiformis (Lam.) Beauv. Th; S.
Manisuris cylindrica (Michx.) Kuntze. H; SE.
Muhlenbergia sobolifera (Muhl.) Trin. H; E.
Panicum agrostoides Spreng. H; E.
Panicum anceps Michx. H; SE.
Panicum boscii Poir. H; SE.
Panicum capillare L. Th; E.
Panicum clandestinum L. H; SE.
Panicum dichotomiflorum Michx. Th; A.
Panicum flexile (Gattinger) Scribn. Th; E.
Panicum hians Ell. H; SE.
Panicum huachucae Ashe var. *fasciculatum* (Torr.) F. T. Hubb. H; A.
Panicum lanuginosum Ell. H; SE.
Panicum lindheimeri Nash. H; A.
Panicum linearifolium Scribn. H; E.
Panicum malacophyllum Nash. H; SE.
Panicum philadelphicum Bernh. Th; E.
Panicum polyanthes Schult. H; SE.
Panicum praecocius Hitchc. & Chase. H; SE.
Panicum ravenelii Scribn. & Merr. H; SE.
Panicum scribnerianum Nash. H; A.
Panicum sphaerocarpon Ell. H; E.
Panicum tennesseense Ashe. H; E.
Panicum virgatum L. H; A.
Paspalum ciliatifolium Michx. H; SE.
Paspalum floridanum Michx. H; SE.
Paspalum laeve Michx. H; SE.
Paspalum pubescens Muhl. H; SE.
Paspalum pubiflorum Rupr. var. *glabrum* Vasey. H; SE.
Phalaris caroliniana Walt. Th; S.
Poa annua L. Th; I.
Poa pratensis L. H; I.
Setaria geniculata (Lam.) Beauv. H; SE.
Setaria lutescens (Weigel) F. T. Hubb. Th; I.
Setaria viridis (L.) Beauv. Th; I.
Sorghastrum nutans (L.) Nash. H; E.
Sorghum halepense (L.) Pers. G; I.
Sorghum vulgare Pers. Th; I.
Spartina pectinata Link. H; E.
Sphenopholis intermedia (Rydb.) Rydb. H; A.
Sphenopholis obtusata (Michx.) Scribn. H; E.
Sporobolus argutus (Nees) Kunth. H; P.
Sporobolus cryptandrus (Torr.) Gray. H; E.
Triodia elongata (Buckl.) Scribn. H; P.
Triodia flava (L.) Smyth. H; SE.
Triodia stricta (Nutt.) Benth. H; MT.
Tripsacum dactyloides (L.) L. H; SE.
Triticum aestivum L. Th; I.
Uniola latifolia Michx. H; SE.
Zea mays L. Th; I.
Zizaniopsis miliacea (Michx.) Doell & Aschers. HH; SE.

Cyperaceae

Carex festucacea Schkuhr. H; A.
Carex frankii Kunth. H; E.
Carex granularis Muhl. Holzinger (1892) H; E.
Carex grisea Wahlenb. var. *globosa* Bailey. H; E.
Carex lupulina Muhl. H; E.
Carex muhlenbergii Schkuhr var. *australis* Olney. H; E.

Carex polygama Schkuhr. Holzinger (1892). H; A.
Carex retroflexa Muhl. H; E.
Carex riparia W. Curtis. Holzinger (1892). H; E.
Carex tetanica Schkuhr var. *meadii* (Dewey) Bailey. H; E.
Carex triceps Michx. var. *hirsuta* (Willd.) Bailey. H; E.
Carex varia Muhl. Holzinger (1892). H; E.
Carex vulpinoidea Michx. H; E.
Cyperus acuminatus Torr. & Hook. Th; W.
Cyperus erythrorhizos Muhl. Th; A.
Cyperus esculentus L. H; A.
Cyperus ferax Rich. Th; A.
Cyperus filiculmis Vahl. H; E.
Cyperus inflexus Muhl. Th; A.
Cyperus ovularis (Michx.) Torr. H; SE.
Cyperus pseudovegetus Steud. H; SE.
Cyperus strigosus L. H; E.
Cyperus uniflorus Torr. & Hook. H; SW.
Eleocharis acuminata (Muhl.) Nees. H; A.
Eleocharis obtusa (Willd.) Schultes. Th; A.
Eleocharis palustris (L.) R. & S. H; A.
Fimbristylis autumnalis (L.) R. & S. Th; SE.
Fimbristylis castanea (Michx.) Vahl var. *puberula* (Michx.) Britton. H; E.
Fuirena simplex Vahl. H; E.
Hemicarpha micrantha (Vahl) Britton. Th; A.
Rynchospora cymosa Ell. H; E.
Rynchospora macrostachya Torr. HH; SE.
Scirpus americanus Pers. HH; A.
Scirpus carinatus (H. & A.) Gray. Th; S.
Scirpus lineatus Michx. H; E.
Scirpus validus Vahl. HH; A.
Scleria ciliata Michx. H; SE.
Scleria triglomerata Michx. H; E.
Stenophyllus capillaris (L.) Britton. Th; A.

Araceae

Arisaema dracontium (L.) Schott. G; E.
Arisaema triphyllum (L.) Torr. G; E.

Lemnaceae

Lemna valdiviana Philippi. HH; A.

Eriocaulaceae

Eriocaulon articulatum (Huds.) Morong. H; E.

Commelinaceae

Commelina crispa Wooton. H; P.
Commelina hirtella Vahl. H; SE.
Commelina nudiflora L. H; SE.
Tradescantia canaliculata Raf. H; E.
Tradescantia ernestiana Anders. & Woods. H; MT.

Juncaceae

Juncus aristulatus Michx. H; E.
Juncus brachycarpus Engelm. H; E.
Juncus diffusissimus Buckley. H; SE.
Juncus dudleyi Wiegand. H; A.
Juncus effusus L. H; A.
Juncus interior Wiegand. H; P.
Juncus marginatus Rostk. H; E.
Juncus polycephalus Michx. H; SE.
Juncus robustus (Engelm.) Coville. H; SE.
Juncus tenuis Willd. H; A.
Juncus torreyi Coville. H; A.

Liliaceae

Allium canadense L. G; E.
Allium mutabile Michx. G; SE.
Allium nuttallii S. Wats. G; P.
Camassia esculenta (Ker) Robinson. G; E.
Erythronium albidum Nutt. ? G; E.
Erythronium mesochoreum Knerr. G; P.
Nothoscordum bivalve (L.) Britton. G; SE.
Polygonatum commutatum (R. & S.) Dietr. G; A.
Smilax bona-nox L. M; SE.
Smilax herbacea L. G; E.
Smilax hispida Muhl. M; E.
Smilax pseudo-china L. M; SE.
Yucca louisianensis Trel. N; MT.
Zygadenus nuttallii Gray. G; P.

Dioscoreaceae

Dioscorea villosa L. G; E.

Amaryllidaceae

Agave virginica L. G; SE.
Cooperia drummondii Herb. G; SW.
Hypoxis hirsuta (L.) Coville. G; E.

Iridaceae

Nemastylis coelestina (Bart.) Nutt. G; SE.
Sisyrinchium campestre Bicknell H; P.
Sisyrinchium gramineum Curtis H; E.

Orchidaceae

Corallorrhiza wisteriana Conrad. G; SE.
Spiranthes cernua L. H; E.
Spiranthes gracilis (Bigel.) Beck. H; E.
Spiranthes vernalis Engelm. & Gray. H; SE.

DICOTYLEDONEAE

Piperaceae

Saururus cernuus L. HH; E.

Salicaceae

Populus deltoides Marsh. MM; E.
Salix longifolia Muhl. M; E.
Salix nigra Marsh. MM; E.
Salix wardii Bebb. M; SE.

Juglandaceae

Carya alba (L.) K. Koch. MM; E.
Carya buckleyi Durand. MM; MT.
Carya cordiformis (Wang.) K. Koch. MM; E.
Carya illinoensis (Wang.) K. Koch. MM; SE.
Juglans nigra L. MM; E.

Betulaceae

Betula nigra L. M; E.

Fagaceae

Quercus borealis Michx.f. var. *maxima* (Marsh.) Ashe. MM; E.
Quercus macrocarpa Michx. MM; E.
Quercus marilandica Muench. MM; E.
Quercus muhlenbergii Engelm. MM; E.
Quercus nigra L. MM; SE.
Quercus palustris Du Roi. MM; E.
Quercus rubra L. MM; SE.
Quercus shumardii Buckl. MM; SE.
Quercus shumardii var. *schneckii* (Britton) Sarg.
Quercus stellata Wang. MM; SE.
x*Quercus stelloides* Palmer (*Q. prinoides* x *Q. stellata*). Palmer (1937).
Quercus velutina Lam. MM; E.

Urticaceae

Boehmeria cylindrica (L.) Sw. H; E.
Celtis laevigata Willd. MM; SE.
Celtis occidentalis L. var. *crassifolia* (Lam.) Gray. MM; E.
Laportea canadensis (L.) Gaud. Nuttall (1821). H; E.
Maclura pomifera (Raf.) Schneider. M; MT.
Morus rubra L. MM; E.
Parietaria pennsylvanica Muhl. Th; A.
Pilea pumila (L.) Gray. Th; E.
Ulmus alata Michx. MM; SE.
Ulmus americana L. MM; E.
Ulmus crassifolia Nutt. MM; SE.
Ulmus fulva Michx. MM; E.
Ulmus serotina Sarg. Sargent (1926). MM; SE.
Urtica chamaedryoides Pursh. Th; SE.

Santalaceae

Commandra pallida A. DC. H; W.

Loranthaceae

Phoradendron flavescens (Pursh) Nutt. Epiphyte; E.

Aristolochiaceae

Aristolochia tomentosa Sims. H; SE.

Polygonaceae

Eriogonum longifolium Nutt. H; MT.
Polygonum acre HBK. Th-H; A.
Polygonum aviculare L. Th; A.
Polygonum convolvulus L. Th; I.
Polygonum dumetorum L. H; I.
Polygonum dumetorum f. *cristatum* (Engelm. & Gray) Robinson.
Polygonum hydropiper L. Th; I.

Polygonum hydropiperoides Michx. H; SE.
Polygonum lapathifolium L. Th; I.
Polygonum pennsylvanicum L. Th; E.
Polygonum ramosissimum Michx. Th; W.
Polygonum tenue Michx. Th; E.
Polygonum virginianum L. H; E.
Rumex altissimus Wood. H; E.
Rumex crispus L. H; I.
Rumex hastatulus Baldw. H; SE.
Rumex obtusifolius L. H; I.

Chenopodiaceae

Chenopodium album L. Th; I.
Chenopodium album var. *viride* (L.) Moq.
Chenopodium ambrosioides L. Th; I.
Chenopodium hybridum L. Th; A.
Chenopodium leptophyllum Nutt. Th; P.
Cycloloma atriplicifolium (Spreng.) Coult. Th; P.
Salsola kali L. var. *tenuifolia* G. F. W. Mey. Th; I.

Amaranthaceae

Acnida tamariscina (Nutt.) Wood. Th; P.
Amaranthus blitoides Wats. Th; I.
Amaranthus hybridus L. Th; I.
Amaranthus retroflexus L. Th; I.
Amaranthus spinosus L. Th; I.
Froelichia gracilis Moq. Th; P.
Iresine paniculata (L.) Kuntze. Th; SE.

Phytolaccaceae

Phytolacca decandra L. H; E.
Rivina humilis L. var. *glabra* L. H; SE.

Nyctaginaceae

Oxybaphus albidus (Walt.) Sweet. H; E.
Oxybaphus linearis (Pursh) Robinson. H; P.

Illecebraceae

Anchia polygonoides Raf. Th; E.

Aizoaceae

Mollugo verticillata L. Th; I.

Caryophyllaceae

Arenaria paula Michx. Th; P.
Arenaria serpyllifolia L. Th; I.
Cerastium brachypodum (Engelm.) Robinson. Th; W.
Cerastium nutans Raf. Th; A.
Cerastium viscosum L. Th; I.
Cerastium vulgatum L. H; I.
Sagina decumbens (Ell.) T. & G. Th; SE.
Saponaria officinalis L. G; I.
Silene antirrhina L. Th; A.
Silene stellata (L.) Ait. f. H; E.
Stellaria media (L.) Cyrill. Th; I.
Stellaria nuttallii T. & G. Th; MT.

Portulacaceae

Claytonia virginica L. G; E.
Portulaca oleracea L. Th; I.
Portulaca pilosa L. Th; SE.
Talinum parviflorum Nutt. H; P.
Talinum teretifolium Pursh. H; E.

Ranunculaceae

Anemone caroliniana Walt. G; E.
Anemone decapetala Ard. G; S.
Anemone virginiana L. H; E.
Clematis pitcheri T. & G. H; P.
Delphinium ajacis L. Th; I.
Delphinium penardi Huth. H; P.
Isopyrum biternatum (Raf.) T. & G. H; E.
Myosurus minimus L. Th; A.
Ranunculus abortivus L. H; E.
Ranunculus fascicularis Muhl. H; E.
Ranunculus micranthus Nutt. H; E.
Thalictrum dasycarpum Fisch. & Lall. H; A.

Menispermaceae

Cocculus carolinus (L.) DC. M; SE.
Menispermum canadense L. M; E.

Berberidaceae

Podophyllum peltatum L. G; E.

Lauraceae

Benzoin aestivale (L.) Nees. M; E.
Sassafras variifolium (Salisb.) Kuntze. M; E.

Fumariaceae

Corydalis aurea Willd. H; A.
Corydalis crystallina Engelm. H; MT.
Corydalis flavula (Raf.) DC. H; E.
Corydalis micrantha Gray. Holzinger (1892). H; E.

Cruciferae

Arabis canadensis L. H; E.
Arabis virginica (L.) Trel. Th-H; S.
Camelina microcarpa Andrz. Th; I.
Capsella bursa-pastoris (L.) Medic. Th; I.
Cardamine pennsylvanica Muhl. Th; E.
Draba brachycarpa Nutt. Th; A.
Draba caroliniana Walt. Th; E.
Iodanthus pinnatifidus (Michx.) Steud. H; E.
Lepidium virginicum L. H; E.
Radicula palustris (L.) Moench. Th-H; A.
Radicula sessiliflora (Nutt.) Greene. Th-H; SE.
Radicula sinuata (Nutt.) Greene. H; A.
Selenia aurea Nutt. Th; MT.
Sisymbrium canescens Nutt. Th-H; A.

Capparidaceae

Polanisia trachysperma T. & G. Th; W.

Crassulaceae

Penthorum sedoides L. H; E.
Sedum nuttallianum Raf. Th; MT.
Sedum pulchellum Michx. H; SE.

Saxifragaceae

Philadelphus pubescens Loisel. N; SE.
Ribes aureum Pursh. N; P.
Saxifraga texana Buckl. H; MT.

Platanaceae

Platanus occidentalis L. MM; E.

Rosaceae

Agrimonia mollis (T. & G.) Britton. H; E.
Amelanchier canadensis (L.) Medic. M; E.
Crataegus bellica Sarg. M; MT.
Crataegus dallasiana Sarg. M; MT.
Crataegus engelmannii Sarg. M; P.
Crataegus mollis (T. & G.) Scheele. M; P.
Crataegus trianthophora Sarg. ? N; MT.
Crataegus viridis L. M; SE.
Fragaria virginiana Duchesne var. *illinoensis* (Prince) Gray. H; E.
Geum canadense Jacq. H; E.
Gillenia stipulata (Muhl.) Trel. H; E.
Potentilla canadensis L. H; E.
Prunus americana Marsh. M; E.
Prunus angustifolia Marsh. M; SE.
Prunus hortulana Bailey. M; P.
Prunus serotina Ehrh. MM; E.
Rosa foliosa Nutt. N; MT.
Rosa pratincola Greene. N; P.
Rosa setigera Michx. N; E.
Rubus trivialis Michx. N; SE.
Rubus villosus Ait. N; E.

Leguminosae

Acacia angustissima (Mill.) Kuntze. N; SW.
Amorpha canescens Pursh. N; P.
Amorpha fruticosa L. N; E.
Amorpha fruticosa var. *angustifolia* Pursh.
Amphicarpa monoica (L.) Ell. H; E.
Amphicarpa pitcheri T. & G. H; E.
Apios tuberosa Moench. H; E.
Astragalus canadensis L. H; E.
Astragalus mexicanus A. DC. H; P.
Baptisia australis (L.) R. Br. H; SE.
Baptisia bracteata Ell. H; E.
Baptisia leucantha T. & G. H; E.
Cassia chamaecrista L. Th; E.
Cassia medsgeri Shafer. H; SE.
Cassia nictitans L. Th; SE.
Cassia tora L. Th; SE.
Cercis canadensis L. M; E.
Cladrastis lutea (Michx. f.) Koch. M; SE.
Clitoria mariana L. H; SE.
Crotalaria sagittalis L. Th; E.
Desmanthus illinoensis (Michx.) MacM. H; E.

Desmodium bracteosum (Michx.) DC. H; E.
Desmodium canescens (L.) DC. H; E.
Desmodium grandiflorum (Walt.) DC. H; E.
Desmodium laevigatum (Nutt.) DC. H; SE.
Desmodium obtusum (Muhl.) DC. H; E.
Desmodium paniculatum (L.) DC. H; E.
Desmodium sessilifolium (Torr.) T; & G. H; E.
Desmodium viridiflorum (L.) Beck. H; E.
Galactia volubilis (L.) Britton. H; SE.
Gleditsia triacanthos L. MM; E.
Gymnocladus dioica (L.) Koch. MM; E.
Hosackia americana (Nutt.) Piper. Th; E.
Indigofera leptosepala Nutt. H; SW.
Lathyrus pusillus Ell. Th; SE.
Lespedeza capitata Michx. H; E.
Lespedeza capitata var. *longifolia* (DC.) T. & G.
Lespedeza frutescens (L.) Britton. H; E.
Lespedeza hirta (L.) Hornem. H; E.
Lespedeza procumbens Michx. H; SE.
Lespedeza repens (L.) Bart. H; E.
Lespedeza simulata Mackenzie & Bush. H; SE.
Lespedeza striata (Thunb.) H. & A. Th; I.
Lespedeza stuvei Nutt. H; E.
Lespedeza stuvei var. *neglecta* Britton.
Lespedeza violacea (L.) Pers. H; E.
Medicago sativa L. H; I.
Melilotus alba Desv. Th-H; I.
Melilotus officinalis (L.) Lam. Th-H; I.
Neptunia lutea (Leavenw.) Benth. H; SE.
Parosela lanata (Spreng.) Britton. H; P.
Petalostemum candidum Michx. H; P.
Petalostemum multiflorum Nutt. H; P.
Petalostemum purpureum (Vent.) Rydb. H; P.
Psoralea pedunculata (Mill.) Vail. H; SE.
Psoralea tenuiflora Pursh. H; P.
Rhynchosia latifolia Nutt. H; MT.
Robinia pseudo-acacia L. MM; SE.
Schrankia uncinata Willd. H; E.
Sesbania macrocarpa Muhl. Th; S.
Strophostyles helvola (L.) Britton. Th; E.
Strophostyles pauciflora (Benth.) Wats. Th; P.
Stylosanthes biflora (L.) BSP. H; SE.
Stylosanthes biflora var. *hispidissima* (Michx.) Pollard & Ball.
Tephrosia onobrychoides Nutt. H; SE.
Tephrosia virginiana (L.) Pers. H; E.
Tephrosia virginiana var. *holosericea* (Nutt.) T. & G.
Trifolium pratense L. H; I.
Trifolium procumbens L. Th; I.
Trifolium repens L. H; I.
Vicia caroliniana Walt. H; E.
Vicia micrantha Nutt. H; SE.

Linaceae

Linum medium (Planch.) Britton. H; E.
Linum sulcatum Riddell. Th; E.

Oxalidaceae

Oxalis interior (Small) Fedde. H; MT.
Oxalis stricta L. H; E.
Oxalis violacea L. G; E.

Geraniaceae

Geranium carolinianum L. Th; A.

Zygophyllaceae

Tribulus terrestris L. Th; I.

Rutaceae

Ptelea trifoliata L. N; E.
Zanthoxylum americanum Mill. M; E.

Polygalaceae

Polygala incarnata L. Th; E.
Polygala sanguinea L. Th; E.
Polygala verticillata L. Th; E.

Euphorbiaceae

Acalypha gracilens Gray. Th; SE.
Acalypha ostryaefolia Riddell. Th; SE.
Acalypha virginica L. Th; E.
Croton capitatus Michx. Th; SE.
Croton glandulosus L. var. *septentrionalis* Muell. Arg. Th; SE.
Croton lindheimerianus Scheele. Th; P.
Croton monanthogynus Michx. Th; SE.
Crotonopsis linearis Michx. Th; SE.
Euphorbia corollata L. H; E.

Euphorbia dentata Michx. Th; P.
Euphorbia dictyosperma Fisch. & Mey. Th; P.
Euphorbia glyptosperma Engelm. Th; A.
Euphorbia heterophylla L. Th-H; E.
Euphorbia maculata L. Th; E.
Euphorbia malaca (Small) Little. Th; MT.
Euphorbia marginata Pursh. Th; I.
Euphorbia petaloidea Engelm. Th; P.
Euphorbia preslii Guss. Th; E.
Euphorbia serpens HBK. Th; P.
Phyllanthus carolinensis Walt. Th; SE.
Stillingia sylvatica L. H; SE.
Tragia nepetaefolia Cav. H; S.
Tragia ramosa Torr. H; S.

Anacardiaceae

Rhus canadensis Marsh. N; A.
Rhus canadensis var. *trilobata* (Nutt.) Gray.
Rhus copallina L. N; E.
Rhus glabra L. N; E.
Rhus toxicodendron L. M; A.
Rhus toxicodendron var. *radicans* (L.) Torr.

Aquifoliaceae

Ilex decidua Walt. M; SE.

Celastraceae

Celastrus scandens L. M; E.
Evonymus atropurpureus Jacq. N; E.

Aceraceae

Acer negundo L. MM; E.
Acer saccharinum L. MM; E.
Acer saccharum Marsh. MM; E.

Sapindaceae

Aesculus glabra Willd. var. *leucodermis* Sarg. N; E.
Sapindus drummondii H. & A. MM; SW.

Rhamnaceae

Berchemia scandens (Hill) Trel. N; SE.
Ceanothus americanus L. N; E.
Rhamnus caroliniana Walt. M; SE.

Vitaceae

Cissus ampelopsis Pers. M; SE.
Cissus arborea (L.) Des Moulins. M; SE.
Cissus incisa (Nutt.) Des Moulins. N; S.
Parthenocissus quinquefolia (L.) Planch. M; E.
Vitis aestivalis Michx. M; E.
Vitis cinerea Engelm. M; P.
Vitis cordifolia Michx. M; E.
Vitis vulpina L. M; E.

Malvaceae

Abutilon theophrasti Medic. Th; I.
Callirhoe alcaeoides (Michx.) Gray. H; I.
Callirhoe digitata Nutt. H; MT.
Hibiscus lasiocarpos Cav. H; SE.
Hibiscus militaris Cav. H; E.
Malvastrum angustum Gray. Th; P.
Sida spinosa L. Th; E.

Tamaricaceae

Tamarix gallica L. M; I.

Hypericaceae

Ascyrum hypericoides L. Ch; SE.
Hypericum cistifolium Lam. H; P.
Hypericum drummondii (Grev. & Hook.) T. & G. Th; SE.
Hypericum mutilum L. Th; E.
Hypericum punctatum Lam. H; E.

Cistaceae

Lechea tenuifolia Michx. H; E.
Lechea villosa Ell. H; E.

Violaceae

Viola emarginata Le Conte. H; SE.
Viola eriocarpa Schwein. H; E.
Viola lovelliana Brainerd. H; MT.
Viola missouriensis Greene. H; MT.
Viola pedatifida G. Don. *Brainerd*, Herb. Field. H; P.
Viola rafinesquii Greene. Th; E.
Viola sororia Willd. H; E.

Passifloraceae

Passiflora incarnata L. H; SE.
Passiflora lutea L. H; SE.

Loasaceae

Mentzelia oligosperma Nutt. Th; P.

Cactaceae

Opuntia humifusa Raf. Stem succulent; P.

Thymelaeaceae

Dirca palustris L. Palmer (1924). N; E.

Lythraceae

Ammannia coccinea Rottb. Th; E.
Cuphea petiolata (L.) Koehne. Th; SE.
Lythrum lanceolatum Ell. H; SE.
Rotala ramosior (L.) Koehne. Th; A.

Onagraceae

Gaura biennis L. H; E.
Gaura parviflora Dougl. H; W.
Jussiaea decurrens (Walt.) DC. H; SE.
Jussiaea diffusa Forsk. HH; SE.
Ludvigia alternifolia L. H; E.
Ludvigia glandulosa Walt. H; SE.
Ludvigia palustris (L.) Ell. H; A.
Oenothera biennis L. H; E.
Oenothera laciniata Hill. Th-H; E.
Oenothera laciniata var. *grandiflora* (Walt.) Robinson.
Oenothera linifolia Nutt. Th; SE.
Oenothera rhombipetala Nutt. H; P.
Oenothera speciosa Nutt. H; SW.
Oenothera triloba Nutt. H; S.

Umbelliferae

Ammoselinum butleri (Engelm.) Coult. & Rose. Th; MT.
Chaerophyllum texanum Coult. & Rose. Th; MT.
Cicuta maculata L. H; E.
Cryptotaenia canadensis (L.) DC. H; E.
Cynosciadium pinnatum DC. Th; MT.
Daucus pusillus Michx. Th; A.
Eryngium yuccifolium Michx. H; E.
Polytaenia nuttallii DC. H; P.
Ptilimnium nuttallii (DC.) Britton. Th; MT.
Sanicula canadensis L. H; E.
Spermolepis divaricata (Walt.) Britton. Th; SE.
Spermolepis echinata (Nutt.) Heller. Th; S.
Spermolepis patens (Nutt.) Robinson. Th; P.
Taenidia integerrima (L.) Drude. H; E.
Torilis anthriscus (L.) Bernh. Th; I.
Trepocarpus aethusae Nutt. Th; MT.
Zizia aurea (L.) Koch. H; E.

Cornaceae

Cornus asperifolia Michx. M; E.
Cornus florida L. M; E.
Nyssa sylvatica Marsh. MM; E.

Ericaceae

Vaccinium arboreum Marsh. M; SE.
Vaccinium vacillans Kalm. N; SE.

Primulaceae

Androsace occidentalis Pursh. Th; P.
Centunculus minimum L. Th; A.
Dodecatheon meadia L. H; E.
Samolus floribundus HBK. H; A.

Sapotaceae

Bumelia lanuginosa (Michx.) Pers. M; SE.

Ebenaceae

Diospyros virginiana L. M; SE.

Oleaceae

Forestiera acuminata (Michx.) Poir. M; SE.
Fraxinus americana L. MM; E.
Fraxinus pennsylvanica Marsh. MM; E.

Loganiaceae

Polypremum procumbens L. Th; SE.

Gentianaceae

Eustoma russellianum (Hook.) Griseb. Th; P.
Sabatia angularis (L.) Pursh. Th-H; E.
Sabatia campestris Nutt. Th-H; MT.

Apocynaceae

Amsonia tabernaemontana Walt. H; SE.
Apocynum cannabinum L. H; E.
Apocynum cannabinum var. *pubescens* (R. Br.) DC.

Asclepiadaceae

Acerates augustifolia (Nutt.) Decne. H; P.
Acerates floridana (Lam.) Hitchc. H; E.
Acerates viridiflora Ell. H; E.
Asclepias amplexicaulis J. E. Smith. H; E.
Asclepias quadrifolia Jacq. H; E.
Asclepias tuberosa L. H; E.
Asclepias verticillata L. H; E.
Asclepiodora viridis (Walt.) Gray. H; SE.
Gonolobus laevis Michx. H; SE.
Vincetoxicum gonocarpos Walt. H; SE.

Convolvulaceae

Convolvulus arvensis L. H; I.
Cuscuta arvensis Beyrich. Th; A.
Cuscuta cuspidata Engelm. Th; P.
Cuscuta gronovii Willd. Th; E.
Ipomoea hederacea Jacq. Th; I.
Ipomoea lacunosa L. Th; SE.
Ipomoea pandurata (L). G. F. W. Mey. H; E.

Polemoniaceae

Gilia rubra (L.) Heller. H; SE.
Phlox divaricata L. H; E.
Phlox pilosa L. H; E.

Hydrophyllaceae

Ellisia nyctelea L. Th; E.
Nama hispidum Gray. *Schenck*, Herb. Field. Th; SW.
Nama ovatum (Nutt.) Britton. H; SE.
Phacelia dubia (L.) Small. Holzinger (1892). Th; E.
Phacelia hirsuta Nutt. Th; SE.

Boraginaceae

Heliotropium convolvulaceum (Nutt.) Gray. Th; P.
Heliotropium indicum L. Th; I.
Heliotropium tenellum (Nutt.) Torr. Th; S.
Lappula virginiana (L.) Greene. H; E.
Lithosperum angustifolium Michx. H; W.
Myosotis virginica (L.) BSP. Th; E.
Onosmodium occidentale Mackenzie. H; P.

Verbenaceae

Lippia lanceolata Michx. H; A.
Lippia nodiflora (L.) Michx. H; E.
Verbena angustifolia Michx. H; E.
Verbena bracteosa Michx. Th; A.
Verbena canadensis (L.) Britton. H; SE.
Verbena hastata L. H; A.
Verbena pumila Rydb. H; MT.
Verbena stricta Vent. H; P.
Verbena urticaefolia L. H; E.

Labiatae

Agastache nepetoides (L.) Kuntze. H; E.
Hedeoma hispida Pursh. Th; E.
Isanthus brachiatus (L.) BSP. Th; E.
Lamium amplexicaule L. Th-H; I.
Lycopus americanus Muhl. H; A.
Marrubium vulgare L. H; I.
Monarda dispersa Small. Th; S.
Monarda mollis L. H; A.
Monarda punctata L. H; E.
Monarda russelliana Nutt. H; MT.
Nepeta cataria L. H; I.
Perilla frutescens (L.) Britton. Th; I.
Physostegia virginiana (L.) Benth. H; E.
Prunella vulgaris L. H; A.
Pycnanthemum flexuosum (Walt.) BSP. H; E.
Salvia azurea Lam. var. *grandiflora* Benth. H; P.
Salvia lyrata L. H; SE.
Satureja glabra (Nutt.) Fernald. H; E.
Scutellaria lateriflora L. H; A.
Scutellaria parvula Michx. H; E.
Scutellaria versicolor Nutt. H; E.
Stachys tenuifolia Willd. H; E.
Teucrium canadense L. H; E.

Solanaceae

Datura stramonium L. Th; I.
Physalis angulata L. Th; P.
Physalis heterophylla Nees. H; E.
Physalis missouriensis Mack. & Bush. Th; MT.
Physalis mollis Nutt. var. *cinerascens* (Dunal) Gray. H; SW.
Physalis pubescens L. Th; S.
Physalis subglabrata Mack. & Bush. H; E.
Physalis virginiana Mill. H; E.
Solanum carolinense L. H; E.
Solanum elaeagnifolium Cav. H; SW.
Solanum nigrum L. Th; E.
Solanum rostratum Dunal. Th; P.
Solanum torreyi Gray. H; MT.

Scrophulariaceae

Bacopa acuminata (Walt.) Robinson. H; SE.
Buchnera americana L. H; E.
Castilleja coccinea (L.) Spreng. Th-H; E.
Castilleja purpurea G. Don. H; SW.
Collinsia violacea Nutt. Th; MT.
Conobea multifida (Michx.) Benth. Th; P.
Gerardia aspera Dougl. Th; P.
Gerardia auriculata Michx. Th; E.
Gerardia grandiflora Benth. H; E.
Gerardia grandiflora var. *serrata* (Torr.) Robinson.
Gerardia heterophylla Nutt. Th; MT.
Gerardia sphaerocarpa Ell. Th; SE.
Gratiola virginica L. Holzinger (1892). Th; A.
Ilysanthes anagallidea (Michx.) Robinson. Th; A.
Linaria canadensis (L.) Dumont. Th-H; A.
Mimulus alatus Ait. H; E.
Pedicularis canadensis L. H; E.
Penstemon laevigatus Ait. var. *digitalis* (Sweet) Gray. H; SE.
Pentstemon tubiflorus Nutt. H; MT.
Scrophularia marylandica L. H; E.
Verbascum blattaria L. H; I.
Verbascum thapsus L. H; I.
Veronica arvensis L. Th; I.
Veronica peregrina L. Th; A.

Orobanchaceae

Orobanche ludoviciana Nutt. G; W.

Bignoniaceae

Catalpa bignonioides Walt. M; I.
Tecoma radicans (L.) Juss. M; SE.

Acanthaceae

Dianthera americana L. H; E.
Diclipiera brachiata (Pursh) Spreng. Th; SE.
Ruellia ciliosa Pursh. H; E.
Ruellia pedunculata Torr. H; MT.
Ruellia strepens L. H; E.

Phrymaceae

Phryma leptostachya L. H; E.

Plantaginaceae

Plantago aristata Michx. Th; W.
Plantago elongata Pursh. Th; SE.
Plantago purshii R. & S. Th; W.
Plantago rhodosperma Decne. Th-H; SW.
Plantago rugelii Decne. H; E.
Plantago virginica L. Th-H; E.

Rubiaceae

Cephalanthus occidentalis L. N; A.
Diodia teres Walt. Th; SE.
Galium aparine L. Th; E.
Galium circaezans Michx. H; E.
Galium pilosum Ait. H; E.
Galium triflorum Michx. H; A.
Galium virgatum Nutt. Th; SE.
Houstonia angustifolia Michx. H; SE.
Houstonia minima Beck. Th; P.
Spermacoce glabra Michx. H; SE.

Caprifoliaceae

Sambucus canadensis L. N; E.
Symphoricarpos orbiculatus Moench. N; E.
Triosteum aurantiacum Bicknell. H; E.
Triosteum perfoliatum L. H; SE.
Viburnum rufidulum Raf. M; SE.

Valerianaceae

Valerianella longiflora (T. & G.) Walp. Th; MT.
Valerianella nuttallii (T. & G.) Walp. Th; MT.
Valerianella radiata (L.) Dufr. Th; E.
Valerianella stenocarpa (Engelm.) Krok. Th; MT.

Cucurbitaceae

Citrullus vulgaris Schrad. Th; I.
Cucurbita foetidissima HBK. H; SW.
Melothria pendula L. H; SE.
Sicyos angulatus L. Th; E.

Campanulaceae

Campanula americana L. Th; E.
Specularia biflora (R. & P.) F. & M. Th; S.
Specularia leptocarpa (Nutt.) Gray. Th; P.
Specularia perfoliata (L.) A. DC. Th; A.

Lobeliaceae

Lobelia cardinalis L. H; E.
Lobelia leptostachys A. DC. H; SE.
Lobelia puberula Michx. H; SE.
Lobelia spicata Lam. H; E.

Compositae

Achillea lanulosa Nutt. H; W.
Actinomeris alternifolia (L.) DC. H; SE.
Ambrosia artemisiifolia L. Th; A.
Ambrosia bidentata Michx. Th; MT.
Ambrosia psilostachya DC. H; W.
Ambrosia trifida L. Th; E.
Amphiachryis dracunculoides (DC.) Nutt. Th; P.
Antennaria campestris Rydb. H; P.
Antennaria plantaginifolia (L.) Richards. H; E.
Anthemis cotula L. Th; I.
Aphanostephus skirrobasis (DC.) Trel. Th-H; S.
Aplopappus ciliatus (Nutt.) DC. Th; MT.
Aplopappus divaricatus (Nutt.) Gray. Th-H; SE.
Arctium minus Bernh. H; I.
Artemisia mexicana Willd. H; P.
Artemisia vulgaris L. H; I.
Aster azureus Lindl. H; E.
Aster drummondii Lindl. H; E.
Aster exilis Ell. Th; SE.
Aster lateriflorus (L.) Britton. H; E.
Aster multiflorus Ait. H; E.
Aster oblongifolius Nutt. H; E.
Aster patens Ait. H; E.
Aster sericeus Vent. H; P.
Aster turbinellus Lind. H; P.
Baccharis salicina T. & G. N; P.
Bellis integrifolia Michx. Th-H; SE.
Bidens bipinnata L. Th; S.
Bidens involucrata (Nutt.) Britton. ThH; SE.
Bidens vulgata Greene. Th; A.
Boltonia diffusa Ell. H; SE.
Boltonia latisquama Gray. H; MT.
Brauneria pallida (Nutt.) Britton. H; P.
Cacalia tuberosa Nutt. H; P.
Centaurea americana Nutt. Th; SW.
Chaetopappa asteroides DC. Th; P.
Chrysopsis pilosa Nutt. Th; Mt.
Chrysopsis villosa Nutt. H; P.
Cirsium altissimum (L.) Spreng. H; E.
Coreopsis grandiflora Hogg. H; SE.
Coreopsis tinctoria Nutt. Th; E.
Eclipta alba (L.) Hassk. Th; SE.
Elephantopus carolinianus Willd. H; SE.
Erigeron annuus (L.) Pers. Th; E.
Erigeron canadensis L. Th; A.
Erigeron divaricatus Michx. Th; P.
Erigeron philadelphicus L. H; A.
Erigeron ramosus (Walt.) BSP. Th; A.
Eupatorium altissimum L. H; E.
Eupatorium coelestinum L. H; E.
Eupatorium perfoliatum L. H; E.
Eupatorium serotinum Michx. H; E.
Eupatorium urticaefolium Reichard. H; E.
Evax prolifera Nutt. *Schenck*, Herb. Field. Th; P.
Gaillardia lanceolata Michx. Th-H; SE.
Gnaphalium polycephalum Michx. Th; E.
Gnaphalium purpureum L. H; E.
Grindelia lanceolata Nutt. H; SE.
Grindelia squarrosa (Pursh) Dunal. H; P.
Helenium tenuifolium Nutt. Th; SE.
Helianthus annuus L. Th; W.
Helianthus grosseserratus Martens. H; E.
Helianthus hirsutus Raf. H; E.
Helianthus mollis Lam. H; SE.
Helianthus petiolaris Nutt. Th; W.
Helianthus scaberrimus Ell. H; P.
Helianthus tuberosus L. H; E.
Heliopsis scabra Dunal. H; A.

Heterotheca subaxillaris (Lam.) Britton & Rusby. Th-H; S.
Hieracium longipilum Torr. H; P.
Hymenopappus caroliniensis (Lam.) Porter. H; SE.
Iva angustifolia Nutt. Th; MT.
Iva ciliata Willd. Th; P.
Krigia dandelion (L.) Nutt. H; SE.
Krigia virginica (L.) Willd. Holzinger (1892). Th; E.
Kuhnia eupatorioides L. H; E.
Lactuca canadensis L. H; A.
Lactuca floridana (L.) Gaertn. Th; SE.
Lactuca hirsuta Muhl. H; E.
Lactuca sagittifolia Ell. H; E.
Lactuca scariola L. var. *integrata* Gren. & Godr. H; I.
Lepachys columnaris (Sims) T. & G. H; W.
Lepachys pinnata (Vent.) T. & G. H; E.
Liatris punctata Hook. G; P.
Liatris pycnostachya Michx. G; P.
Liatris scariosa Willd. G; E.
Liatris squarrosa Willd. G; E.
Mikania scandens (L.) Willd. H; E.
Parthenium hysterophorus L. H; E.
Pluchea petiolata Cass. Th; SE.
Polymnia uvedalia L. H; SE.
Prenanthes aspera Michx. H; P.
Pyrrhopappus carolinianus (Walt.) DC. H; SE.
Rudbeckia amplexicaulis Vahl. Th; MT.
Rudbeckia grandiflora Gmelin. H; MT.
Rudbeckia hirta L. H; E.
Rudbeckia triloba L. H; E.
Senecio imparipinnatus Klatt. *Schenck*, Herb. Field. Th-H; MT.
Senecio obovatus Muhl. H; E.
Serenia oppositifolia (Raf.) Kuntze. Th; SE.
Silphium integrifolium Michx. H; P.
Silphium laciniatum L. H; P.
Silphium perfoliatum L. H; P.
Solidago altissima L. H; E.
Solidago bootii Hook. H; SE.
Solidago gymnospermoides (Greene) Fernald. H; MT.
Solidago missouriensis Nutt. H; W.
Solidago petiolaris Ait. H; SE.
Solidago radula Nutt. H; MT.
Solidago rigida L. H; E.
Solidago serotina Ait. H; A.
Solidago ulmifolia Muhl. H; E.
Sonchus asper (L.) Hill. Th; I.
Taraxacum vulgare (Lam.) Schrank. H; I.
Verbesina virginica L. H; SE.
Vernonia altissima Nutt. H; E.
Vernonia baldwini Torr. H; P.
Vernonia crinita Raf. H; MT.
Vernonia missurica Raf. H; P.
Vernonia noveboracensis Willd. H; SE.
Xanthium chinense Mill. Th; A.
Xanthium italicum Moretti. Th; A.
Xanthium pennsylvanicum Wallr. Th; E.
Xanthium speciosum Kearney. Th; P.

Summary

The flora of Muskogee County, Oklahoma, based upon collections by the author from 1925 to 1929, includes 11 species of pteridophytes, 2 species of gymnosperms, and 816 species of angiosperms. One-third of these are in the three largest families, Compositae, Gramineae, and Leguminosae.

Muskogee County is located in the forest-grassland transition area of northeastern Oklahoma and contains floras of both the oak-hickory forest and the tall-grass prairie. In relationships the flora is clearly eastern. Species at or near the limits of their ranges here include eastern, southeastern, and western species.

The biological spectrum of Muskogee County based upon Raunkiaer's life forms shows that hemicryptophytes and other herbaceous forms are outstanding. Only one-seventh of the species are woody.

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TUCSON, ARIZ.

Aceretum rubri: the Red Maple Swamp Forest of Central Long Island

Stanley A. Cain and Wm. T. Penfound [1]

Introduction

No red maple forest type is recognized by the Society of American Foresters in their "Forest Cover Types of the United States" (1932). This is due to the small area of the usual stands of this type. They state, however, with respect to their type 26, Black ash-American elm-red maple, that in New England red maple often predominates and may be found in pure stand. Type 26 occurs throughout the Lake States and New England and adjacent regions. It is described as occupying "moist to wet muck or shallow peat soils, in swamps, gullies and small depressions of slow drainage or in elongated areas along small sluggish streams, occasionally covering extensive swamps." It is a minor type unimportant commercially. From the forester's point of view, the red maple swamp type here under consideration is nothing more than a variant. From an academic standpoint and for more intensive plant sociological studies it is well to recognize it as a distinct association, especially since the codominants of type 26 are absent from these stands.

Conard (1935) gave brief descriptions of a large number of plant associations of Central Long Island. Among them he names two red maple associations: *Aceretum osmundaceum* and *Aceretum rubri.* As he describes them, they are obviously closely related associations, the former being richer and more varied. Our studies indicate that this distinction is scarcely valid and that all such stands should now be considered as belonging to *Aceretum rubri.* Two red maples are involved in this type. In addition to the regular species, *Acer rubrum,* we find *Acer carolinianum* on the wetter sites at most stations. As to the latter, our observations would seem to indicate that *A. carolinianum* is scarcely valid as a species—in which case the name, *A. rubrum* var. *tridens,*[2] is preferable. (However this taxonomic matter is not treated here). In fact, we did not separate these plants in the following statistical studies of the forest type, since they are often difficult to distinguish.

The red maple swamp forest type occurs in Central Long Island on the *Meadow Soil Type* (Lounsbury, 1928). "*Meadow* includes a number of scattered poorly drained areas in which the soil is of such a variable character as to be difficult to classify. *Meadow* occurs along fresh-water drainage ways

1 Dr. Penfound collaborated with the senior author on the bryocoenological work; some assistance in the field work on the other communities was given by 1935 and 1936 students in Plant Sociology at The Biological Laboratory, Cold Spring Harbor, Long Island, N. Y.

2 The nomenclature of the trees follows Sudworth, 1927.

where the free passage of water is obstructed by low gradient and where in many places springs keep the surface of the ground saturated. The presence of a rank growth of water-loving trees and plants, whose roots, stems, and foliage occupy the ground also impedes free drainage."

This association has been studied in some detail at five stations accessible from the Laboratory at Cold Spring Harbor. The five stations are designated as follows:

North Shore:
Third Lake, an old artificial lake on Cold Spring Creek;
Hauppauge: on the Nissequogue River above Wyandanch Lake;
South Shore:
Wyandanch: Carrells River;
Santapogue: on the Santapogue River near Babylon;
Massapequa: on Massatayun Creek.

The five stations are contained roughly within a square 12 miles on a side. The Third Lake station is at the northwest corner and the Massapequa station is at the southwest corner of such a square. The Santapogue station is near the center of the south side, the Hauppauge station interior from the southeast corner, and the Wyandach station is interior near the center of the region.

The following point of view has been adopted in this study of the red maple swamp forest association. It is believed that this forest type is really a phytocoenosis, as is true of nearly all, if not all, forest associations. That is, this community as defined in the broad sense is not homogeneous but is made up of several synusiae. Each synusia, or life-form group, is however fairly homogeneous with respect to composition and structure, and habitat relations. These synusiae are, in a large part, the commonly recognized layer societies (trees, shrubs, herbs, etc.), but the division of the phytocoenosis into layer communities does not include all the synusiae present. There remain certain cryptogamic communities of the shrub stools and peat hummocks, of the streams and pools, and those which are corticolous—growing on the bark of trees and shrubs. It is obvious from previous work (see especially references to papers by Lippmaa and Cain) that the best method of studying a phytocoenosis is to study the synusiae separately and, on a basis of this knowledge, to synthesize a picture of the association. This applies not only to studies of community structure and composition but also to investigations of habitat factors (which are not taken up quantitatively in this paper). The following descriptions deal separately with the arborescent, frutescent, herbaceous, and bryophytic synusiae.

A few years ago Lippmaa (1934, 1935) proposed the unistratal association concept. He and some of his students (Pastak, 1935 and Sirgo, 1935) have since described the vegetation of Esthonia on that basis. This concept has been considered by Cain (1934, 1936) with the general conclusion that the synusiae (unistratal communities) are the logical and practical units for analytical studies but that they probably should not be elevated to the rank of associations. Gleason (1936) is convincing in his argumentation that the

layer communities are not independent associations which occupy the same station simultaneously but that they are really interdependent; hence the phytocoenosis is the real ecological unit and should be considered as the association. This was the consensus at the last International Botanical Congress. Lippmaa agreed to this nomenclatural treatment (Sirgo 1935, p. 67) without abandoning his method of study, and rightly so, and as it seems without being completely convinced that his concept of the unistratal association is not without factual basis. He agreed not to designate the unistratal communities (synusiae) as associations but to call them *"unions"* according to the suggestion made by DuRietz and Gams. Sirgo, one of Lippmaa's students, published (1935) a study on this basis.

Our study of the red maple phytocoenosis has revealed the following unions composing the layers:

LIFE-FORM	DOMINANT SPECIES	NAME OF THE UNION
Arborescent	*Acer rubrum* and its var. *tridens*	Acer rubrum union
Frutescent	*Clethra acuminata* *Azalea viscosa*	Clethro-Azalea union
Herbaceous	*Rubus hispidus* *Unifolium canadense* *Spathyema foetida*	Rubus hispidus union Unifolium canadense union Spathyema foetida union

Cryptogamic: Several moss and liverwort communities to be described in a subsequent section of this paper.

Each of these unions has been analyzed by a series of quadrats at each station (in some instances more than one series of quadrats) from which certain data were obtained. The results are expressed in tables which give the floristic assemblage for each union at each station, the frequency percentage for each species, and the dominance class. Coverage is expressed by the following widely used *dominance* classes (Cain, 1932):

DC 5—coverage of 76-100%
DC 4—coverage of 51-75%
DC 3—coverage of 26-50%
DC 2—coverage of 6-25%
DC 1—coverage of 1-5%
DC x—coverage less than 1%

In cases where the same union was analyzed at all five stations, the summary tables also give the constancy for each species.

The size of quadrat employed was adjusted to the nature of the union under investigation. For the arborescent union 10 quadrats of 50 sq. m. each were used. For the frutescent union 4 sq. m. quadrats were adequate. One and 4 sq. m. quadrats were employed for the herbaceous unions, the choice of size depending on the homogeneity and the average total coverage of the stand. The cryptogamic unions, when studied statistically, were sampled by 1 sq. dm. quadrats which were entirely adequate for this small life-form.

It was found in most cases that 10 quadrats constituted an adequate series. Occasionally it was necessary to employ 20 quadrats. The number used was determined by the following considerations. If a series of 10 quadrats revealed the frequency-dominants, i.e. the species obviously of highest coverage and the

most uniformly distributed through the community, and also included all, or nearly all, of the associated species, it was considered adequate. If, however, several species in the stand remained unsampled and there was any uncertainty about the frequency-dominants, the series was extended to 20 quadrats. Some recent papers gave especial consideration to the problems of quadrat area and quadrat number. The authors made use of the species-area curve but also gave attention to coverage and frequency of the species which are encountered late in the quadrat sample series. In other words, they examined the statistics for these species which cause the continued rise of the species-area curve. They were found to be species of low coverage and frequency and never represented the dominants or codominants of the community. In this connection see especially Cain (1935), Cain, Nelson, and McLean (1937), and Penfound and Watkins (1937). Although uniformity in sampling method (quadrat size and number) is desirable when comparisons are to be made, it is probably good to sacrifice rigid uniformity of all samples for the sake of assuring the adequacy of each sample—hence the occasional use of 20 quadrats rather than 10, and the use of 1 or 4 sq. m. quadrats for the herbs, as the particular stand required.

Dominance in the arborescent union was determined on a basal area[3] basis, not on crown coverage, for each species on a 500 sq. m. sample at each station.

The Arborescent Synusia: Acer rubrum Union

This union is definitely dominated by one species of tree together with its variety. The total crown coverage varies from 60 per cent to close to 100 per cent (70 per cent at Massapequa and Santapogue). The larger trees attain a height of 20 m. or a little more although in many places the trees average about 15 m. high (at Massapequa and Santapogue). The majority of the trees along the stream banks have a pistol-butt form and in addition show a strong tendency to develop in clumps. Back from the streams or pond margins the trees are confined to the higher ground composed largely of peaty material built up by mosses and shrubs. The most mature stand studied is the one at Third Lake where progressive deposition has resulted in raising the general level of the soil around the periphery of the stand with the consequent elimination there of the island hummock pattern of the soil surface. The Third Lake station also shows all the younger stages in the development of the phytocoenosis. The associated tree species, as do the maples, in the main make their appearance on the small peaty stools.

Table 1 gives the basal area for each of the five stands of the *Acer rubrum* union which were studied. This table clearly reveals the dominance of red maple (89 per cent of the total basal area) although it shows considerable variation from place to place. The variability of the union is further revealed in Table 2 which gives the density of the trees by three diameter classes. On a basis of this sampling, the basal area ranges from 92 sq. ft, per acre for the Wyandanch station to 216 sq. ft. per acre for the Third station. The lowest

3 Basal area is the circular area in sq. ft., measured at 4.5 feet above the ground, of the tree stems on a sample plot.

TABLE 1

Basal area in square feet, based on one 500 sq. m. plot per stand, for the trees of the red maple swamp forest of Central Long Island.

Species	Localities					Per cent of total	Constancy
	Haup-pauge	Wyan-danch	Third Lake	Santa-pogue	Massa-pequa		
Acer rubrum (with var. *tridens*)	14.92	11.35	26.46	13.68	16.06	89	5
Nyssa sylvatica	3.89			2.09	.80	7	3
Pinus rigida				1.98		2	1
Amelanchier canadensis		.09		.80		1	2
Betula populifolia		.05			.54	–	2
Quercus alba					.56	–	1
Fraxinus americana			.53			–	1
Sassafras variifolium	.02				.09	–	2
Total per station	18.83	11.55	26.99	18.55	18.05		

TABLE 2

Density of tree species by three diameter classes, based on one 500 sq. m. plot per stand, for the red maple swamp forest of Central Long Island.

Species: d. b. h.*	Localities					Totals	
	Haup-pauge	Wyan-danch	Third Lake	Santa-pogue	Massa-pequa		
Acer rubrum (with var. *tridens*)							
1-3 in.	—	4	18	112	80	214	
4-9 in.	14	39	27	75	36	191	
10-plus in.	13	4	26	—	7	50	455
Nyssaa sylvatica							
1-3 in.	3	—	—	2	7	12	
4-9 in.	7	—	—	7	1	15	
10-plus in.	2	—	—	1	1	4	31
Pinus rigida							
1-3 in.	—	—	—	—	—	—	
4-9 in.	—	—	—	3	—	3	
10-plus in.	—	—	—	1	—	1	4
Amelanchier canadensis							
1-3 in.	—	1	—	38	—	39	
4-9 in.	—	1	—	1	—	2	
10-plus in.	—	—	—	—	—	—	41
Betula populifolia							
1-3 in.	—	1	—	—	15	16	
4-9 in.	—	—	—	—	1	1	
10-plus in.	—	—	—	—	—	—	17
Quercus alba							
1-3 in.	—	—	—	—	2	2	
4-9 in.	—	—	—	—	3	3	
10-plus in.	—	—	—	—	—	—	5
Fraxinus americana							
1-3 in.	—	—	4	—	—	4	
4-9 in.	—	—	2	—	—	2	
10-plus in.	—	—	2	—	—	2	8
Sassafras variifolium							
1-3 in.	1	—	—	—	5	6	
4-9 in.	—	—	—	—	—	—	
10-plus in.	—	—	—	—	—	—	6
Totals	40	50	79	240	158	567	

* d. b. h. : diameter breast high, i.e. at 4.5 ft. above the ground.

stem density is at Hauppauge where there are 320 trees per acre. The highest stem density is at Santapogue with about 1900 trees per acre. None of the trees is very large, as is shown by Table 2. Altogether there are 50 maples with a diameter of 10 inches or more and only 7 stems of other species which attain this size class.

TABLE 3

SHRUB COMMUNITY; *Clethro-Azalea* Union of the *Aceretum rubri*, Central Long Island. Sampled by 10 quadrats at 4 sq. m. from each of 5 stations.

Species	Hauppauge F%	Hauppauge DC	Wyandanch F%	Wyandanch DC	Third Lake F%	Third Lake DC	Santapogue F%	Santapogue DC	Massapequa F%	Massapequa DC	Constancy
High constancy: 5/5 or 4/5											
Clethra alnifolia	90	2	100	3	100	3	100	2	100	3	5
Azalea viscosa	90	1	100	2	30	1	100	3	90	3	5
*Viburnum dentatum**	60	1	90	x	50	1	50	2	50	1	5
*Vaccinium corymbosum***	60	2	50	1	60	1	20	x	30	x	5
Benzoin aestivale	60	2	100	2	90	2	---	-	10	x	4
Alnus rugosa	--	-	50	x	20	1	100	2	40	1	4
Viburnum cassinoides	30	1	10	x	--	-	40	1	40	x	4
Smilax rotundifolia	40	x	30	x	30	x	---	-	20	x	4
Medium constancy: 3/5											
Ilex verticillata	20	x	20	x	10	x	--	-	--	-	3
Aronia melanocarpa	--	-	--	-	10	x	20	x	10	x	3
Low constancy: 2/5 or 1/5											
Aronia atropurpurea	20	x	--	-	--	-	70	1	--	-	2
Xolisma ligustrina	--	-	--	-	30	1	30	x	--	-	2
Eubotrys racemosa	30	x	70	x	--	-	--	-	--	-	2
Toxicodendron radicans	40	x	--	-	--	-	--	-	10	x	2
Sambucus canadensis	90	1	--	-	--	-	--	-	--	-	1
Toxicodendron Vernix	--	-	--	-	70	2	--	-	--	-	1
Psedera quinquefolia	40	1	--	-	--	-	--	-	--	-	1
Ilex glabra	--	-	--	-	--	-	30	x	--	-	1
Ilex laevigata	--	-	--	-	--	-	--	-	20	x	1
Viburnum prunifolium	--	-	10	x	--	-	--	-	--	-	1
Rosa palustris	--	-	--	-	10	x	--	-	--	-	1
Vitis Labrusca	--	-	--	-	10	x	--	-	--	-	1
Smilax glauca	--	-	--	-	--	-	--	-	10	x	1
Frequency classes:											
A (10 20%)	2		3		5		2		6		
B (30 40%)	5		1		3		3		3		
C (50 60%)	3		2		2		1		1		
D (70 80%)	-		1		1		1		-		
E (90 100%)	3		4		2		3		2		
Total number of species per stand	13		11		13		10		12		

F%: Frequency per cent. DC: Dominance class.
* Includes also *V. Canbyi*.
** Includes also *V. vicinum*.

The Frutescent Synusia: Clethro-Azalea Union

The shrub community of the red maple phytocoenosis is one dominated by *Clethra alnifolia*[4] and *Azalea viscosa* and may be designated as the *Clethro-Azalea* union. This union shows considerable local variation but none of the 21 species associated with the two dominants is of sufficient importance to designate a sub-community. *Viburnum dentatum, Vaccinium corymbosum, Benzoin asetivale, Alnus rugosa,* and *Toxicodendron Vernix* attain an average coverage in class 2 on the quadrats at one or another station and, on restricted areas, may reach class 4 or 5 coverage. However, considering the union as a whole on Central Long Island, they are not equal to *Clethra* and *Azalea.* At Third Lake a fragmentary layer community occurs with *Benzoin aestivale* and *Ilex verticillata* as the most important species. Associated species include *Viburnum dentatum, Sambucus canadensis, Vaccinium vicinum, Alnus rugosa, Vitis Labrusca,* and *Parthenocissus quinquefolia.* The *Clethro-Azalea* union is rather rich in species for a shrub community under a tree layer.

TABLE 4

SHRUB COMMUNITY; *Clethro-Azalea* union, Massapequa.
Sampled by 10 quadrats at 4 sq. m.

Species	Quadrats	Per cent Frequency	Average Coverage: Dominance Class
Clethra alnifolia	3 2 3 4 3 3 3 1 3 4	100	3
Azalea viscosa	2 – 3 3 3 1 2 3 3 3	90	3
Viburnum dentatum	1 – – x 1 – – – 2 1	50	1
Vaccinum corymbosum	x – 1 1 – – – – – –	30	x
Smilax glauca	x – – – – – – – – –	10	x
Alnus rugosa	– 2 – 1 x – x – – –	40	1
Viburnum cassinoides	– x x – – – – – x x	40	x
Ilex laevigata	– x – – – – – x – –	20	x
Aronia melanocarpa	– x – – – – – – – –	10	x
Smilax rotundifolia	– – x – – – – – x –	20	x
Benzoin aestivale	– – – – – – – x – –	10	x
Toxicodendron radicans	– – – – – – – x – –	10	x

Table 3 summarizes in an adequate manner the sampling at the five stations so that the detailed tables for individual stations are omitted except for Massapequa. These results (Table 4) may be taken as representative of the union. Frequency classes are shown at the bottom of Table 3. It will be noticed that a secondary peak is shown for each station; that is, class E (species of 90 and 100 per cent frequency) are more numerous than class D species. Both of the dominant species for which the union is named fall into class E at every station except for *Azalea* at Third Lake. The validity of this union is further demonstrated by the sampling, in that 10 of the 23 species occur at three or more of the five stations.

On a basis of preliminary sampling the use of a quadrat of 4 sq. m. was

4 All names follow Taylor, 1915, unless otherwise indicated.

settled on because it was the minimum size which would show the secondary frequency peak in Class E and would sample nearly the total flora on a basis of 10 scattered quadrats. A curve for constancy classes likewise shows a secondary peak, in this instance classes 4 and 5 being larger than class 3. The number of species in the five constancy classes are 9:4:2:4:4.

This union does not occur uniformly throughout the phytocoenosis. At Hauppauge, for example, this union averages 75 per cent coverage, ranging from 15 to 90 per cent on different quadrats. In drier places it is decidedly fragmentary. It reaches its greatest richness in species and heaviest coverage on the wettest sites, many of the shrubs growing on soil which is inundated during a considerable part of the year. The union is, however, completely typical of the red maple phytocoenosis on Central Long Island.

The Herbaceous Synusiae: Rubus hispidus Union
Unifolium canadense Union
Spathyema foetida Union

Three herbaceous unions have been recognized in the red maple phytocoenosis at the five stations studied. Each community has been named after the species of highest frequency and coverage in the community. All three unions occurred only at one station, Third Lake. There the *Rubus hispidus* union occupied the driest sites, *Unifolium* union was intermediate, and *Spathyema* union was on the wettest sites. Conard (1935) states that *Spathyema foetida* occurs only on sandy soil. This is not exclusively so. It occurs also on muck and peat soils in the swamps. The typical *Rubus hispidus*[5] union was encountered only at Third Lake. Unions of *Unifolium* and *Spathyema* were both observed at three stations. The four stations other than Third Lake were each characterized by a single herbaceous union, the variety of soil conditions being insufficient for the full development of all three unions. Nine species, including the three which characterize the three unions named, were found to occur in all three unions. Eleven other species were found in the floristic assemblages of two of the three unions of herbs. It is apparent that the three herbaceous unions are closely related to each other. Certain species were sampled only in one community. Wider observations, however, would seem to indicate that they cannot be used to differentiate the unions. It is certainly better in the present study to use frequency-dominants for the characterization of the unions rather than species apparently of high fidelity. Although the edaphic factors were not investigated in this study, observations would suggest that the shift in dominants from the *Rubus* union to the *Spathyema* union is correlated with increasing soil moisture.

Table 5 presents a summary of the results of sampling the herbaceous unions. Altogether 60 per species were found in the quadrats used in the

5 *Rubus hispidus* is not an herb but the union of which it is a part is otherwise completely herbaceous and its affinities are entirely with the other herbaceous unions.

TABLE V

HERBACEOUS COMMUNITIES OF THE RED MAPLE SWAMP FOREST TYPE, CENTRAL LONG ISLAND, N.Y.

COMMUNITY	RUBUS UNION				UNIFOLIUM UNION							SPATHYEMA UNION			SPECIES DISTRIBUTION	
LOCATION	THIRD LAKE				THIRD LAKE					WYANDANCH	HAUPPAUGE	MASSAPEQUA	SANTAPOGUE	THIRD LAKE	NUMBER OF COMMUNITIES OUT OF THREE	NUMBER OF STATIONS OUT OF FIVE
QUADRAT SET	A	B	C	D	A	B	C	D	E	A	A	A	A	A		
QUADRAT AREA IN SQ. M	1	1	1	1	1	1	1	1	1	4	4	4	4	4		
NUMBER OF QUADRATS	10	20	10	10	10	10	10	10	10	10	10	20	10	10		
QUANTITATIVE DATA	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC	F %DC		
DOMINANT SPECIES																
RUBUS HISPIDUS	100 5b	100 5b	100 5	100 5	100 1	60 3	50 x	30 x	85 1	100 1	100 2	85 1	30 x	30 x	3	4
UNIFOLIUM CANADENSE	10 x	25 x	30 x		100 1	80 3	100 5	100 x	100 3	80 x	30 1	100 3	90 x	100 4	3	5
SPATHYEMA FOETIDA	70 2	55 1	30 1	40 1	40 1	30 x		10 x	25 x							
SPECIES OF 3 COMMUNITIES																
SOLIDAGO CAESIA	20 x	15 x							5 x					20 x	3	1
ARISAEMA TRIPHYLLUM		5 x												30 x		
CAREX INTUMESCENS VAR. FERNALDII *	30 x								10 x				10 x		3	1
CAREX RETROFLEXA	30 x	15 x				20 x			15 x	90 x		20 x	30 x	10 x	3	3
THALICTRUM POLYGAMUM		15 x			10 x								100 1		3	3
DRYOPTERIS CRISTATA		10 x			10 x						10 x				3	3
SPECIES OF 2 COMMUNITIES																
OSMUNDA CINNAMOMEA								20 x							2	1
VIOLA CUCULLATA (?STERILE)									5 x						2	1
DRYOPTERIS THELYPTERIS										80 x	40 x		20 x		2	2
DIOSCOREA VILLOSA										60 x		75 3	60 2		2	2
SOLIDAGO ULIGINOSA										40 x		100 3			2	2
ARALIA NUDICAULIS										20 x	20 x	10 3			2	2
CAREX HOWEI										20 x	60 x	100 3		30 x	2	2
CAREX STRICTA		10 x										75 1		10 x	2	2
DRYOPTERIS INTERMEDIA			20 x		10 x	10 x						100 1	60 2	10 x	2	2
CAREX FLEXUOSA		25 x								90 1	70 2				2	2
VIOLA BLANDA (? STERILE)		15 x													2	2
SPECIES ONLY IN RUBUS UNION																
ATHYRIUM ANGUSTUM *	40 1	30 x	10 x												1	1
GLYCINE APIOS	10 x	10 x													1	1
JUNCUS EFFUSUS	20 x	25 x													1	1
IMPATIENS PALLIDA		15 x													1	1
JUNCUS TENUIS		5 x													1	1
ONOCLEA SENSIBILIS		30 x													1	1
LYCOPUS SP? (STERILE)		25 x		20 x											1	1
CLEMATIS VIRGINIANA		10 x													1	1
EUPATORIUM SP? (STERILE)			10 x												1	1
ASTER SP? (STERILE)				10 x											1	1
ASCLEPIAS EXALTATA				10 x											1	1
SPECIES IN UNIFOLIUM UNION ONLY																
CAREX VIRESCENS							10 x								1	1
PANICUM MICROCARPON									15 x						1	1
MEDEOLA VIRGINIANA									10 x	10 x					1	1
MONOTROPA UNIFLORA										40 x					1	1
MAIANTHEMUM STELLATA										10 x					1	1
GYMNADENIOPSIS CLAVELLATA											10 x				1	1
TRACAULON ARIFOLIUM											20 x				1	1
CUSCUTA SP? (STERILE)															1	1
SPECIES IN SPATHYEMA UNION ONLY																
BLEPHARIGLOTTIS LACERA												5 x	10 x	10 x	1	1
OSMUNDA REGALIS												50 1	30 x		1	1
MELAMPYRUM LINEARE												40 1	10 x		1	1
LYCOPUS UNIFLORUS												90 x			1	1
BIDENS DISCOIDEA												85 x			1	1
GLYCERIA PALLIDA												30 x			1	1
LORINSERIA AREOLATA												15 x			1	1
CAREX LEPTALEA												15 x			1	1
LYSIMACHIA PRODUCTA												10 x			1	1
VERBENA URTICAEFOLIA												10 x			1	1
TRIADENUM VIRGINIANUM												10 x			1	1
LILIUM SUPERBUM												10 x			1	1
CHELONE GLABRA												10 x			1	1
SPARGANIUM SIMPLEX												10 x			1	1
PILEA PUMILA												5 x			1	1
GLYCERIA STRIATA												5 x			1	1
CAREX FOLLICULATA												5 x			1	1
POLYGONATUM BIFLORUM												5 x			1	1
FISSIPES ACAULIS												5 x			1	1
EUPATORIUM PERFOLIATUM												5 x			1	1
TRIENTALIS BOREALIS												5 x	40 x		1	1
													10 x			

study. Species names in this table, which are marked by an asterisk, do not follow Taylor, 1915. Names of grasses follow Hitchcock, 1935. The various stations varied widely in the number of species encountered, as shown in the following list:

Third Lake	28 species sampled,
Massapequa	28 species sampled,
Wyanddanch	12 species sampled,
Santapogue	12 species sampled,
Hauppauge	12 species sampled.

The number of species found in any one community was more uniform:

Rubus union	24 species sampled,
Unifolium union	26 species sampled,
Spathyema union	39 species sampled.

There is an increase in floristic richness for the moister communities. Detailed results for each set of quadrats are not presented, however, Tables 6, 7, and 8 show the results for representative stands of each union.

TABLE 6

The *Rubus hispidus* union at Third Lake. Series A, 10 quadrats each 1 sq. m.

Species	Quadrats	Frequency Per cent	Dominance Class
Rubus hispidus	5 4 5 5 5 5 5 5 5 5	100	5
Spathyema foetida	– 2 – 2 – 2 2 2 2 1	70	2
Athyrium angustum	– – 2 – x – 1 – – 1	40	1
Carex retroflexa	x x – – – – – x – –	30	x
Solidago caesia	x – – – – – – – x –	20	x
Juncus effusus	– – – – 1 – x – – –	20	x
Carex intumescens var. *Fernaldii*	– – – – – – – 1 – x	20	x
Unifolium canadense	– x – – – – – – – –	10	x
Glycine Apios	– – x – – – – – – –	10	x

TABLE 7

The *Unifolium canadense* union at Third Lake. Series A, 10 quadrats each 1 sq. m.

Species	Quadrats	Frequency Per cent	Dominance Class
Unifolium canadense	5 4 5 5 5 5 5 5 5 5	100	5
Rubus hispidus	1 x x x 1 x 1 x 1 x	100	1
Spathyema foetida	– 2 – 1 – – – – x x	40	1
Dryopteris cristata	– 2 – – – – – – – –	10	x
Thalictrum polygamum	– x – – – – – – – –	10	x
Dryopteris intermedia	– – x – – – – – – –	10	x

TABLE 8

The *Spathyema foetida* union at Third Lake. Based on 10 quadrats at 1 sq. m.

Species	Quadrats	Frequency Per cent	Dominance Class
Spathyema foetida	5 3 4 4 3 5 4 5 5 5	100	4
Unifolium canadense	1 – – x – – x – – –	30	x
Viola cucullata	– 1 x – 1 – – – – –	30	x
Rubus hispidus	– x x x – – – – – –	30	x
Thalictrum polygamum	– – 1 – 1 – – – – –	20	x
Blephariglottis lacera	– – x – – – – – – –	10	x
Dryopteris cristata	– – – – x 1 – – – –	20	x
Carex intumescens var. *Fernaldii*	– – – – x – – – – –	10	x
Viola blanda	– – – – 1 – – – – –	10	x
Carex stricta	– – – – – 2 – – –	10	x

The herbaceous unions are not always sharply distinguished and are not always closed. Especially where the shrub union is well-developed the herbaceous communities are likely to be fragmentary. The *Unifolium* union at Hauppauge has an average coverage of only 35 per cent, varying from 10 to 85 per cent. At Massapequa the average coverage is 70 per cent.

The Bryophytic Unions[6]

American ecologists have, in general, paid very little attention to the bryophytic flora of the phytocoenoses which they hase studied. Sometimes the more conspicuous species or aggregations are mentioned but attempts at quantitative study have been very few. There is certainly no justification for ignoring such synusiae as are formed by bryophytes, at least in instances where a complete picture of a phytocoenosis is desirable.

Bryophytes may be of considerable ecological significance as well as a characteristic part of a phytocoenosis. They frequently are good indicators of site quality with respect to both edaphic and atmospheric factors. Also, they may react strongly on the habitat, greatly modifying the living conditions for the herbs, shrubs, and trees, especially for the latter during the periods of seed germination and seedling establishment. Conditions of soil moisture are frequently modified by bryophytes, even to the extent of producing impeded drainage and water-logging of the soil. Indirect influences on soil moisture result from peat accumulation which is sometimes attributable to bryophytes. They may contribute directly or indirectly to the production of a more acid soil. They may prevent germination of the seeds of certain plants by forming an obstructive layer over the soil. On the other hand, they may cause or aid in the upbuilding of soil, stools, or hummocks on wet sites, which elevations subsequently provide suitable seed beds for certain plants which otherwise would be unable to play a part in the phytocoenosis. Under certain conditions they may either speed up or retard the rate of succession of preclimax communities.

In some forest types the *Bodenschicht*[7] is so well developed that the community nature of the moss layer on the soil is obvious. This is true, for example, of the *Hylocomium splendens* union which is so characteristic of the *Abietum Fraseri* of the Great Smoky Mountains (Cain 1935). In the majority of forest types no such extensive moss carpet is found. The difficulty of recognizing bryophytic unions as they more frequently occur is the result of their fragmentary nature or of the small area which closed stands may dominate. Many of the species may be well-adapted only for a certain set of environmental conditions which occur frequently, perhaps, but in a very limited area. As the microhabitat varies so will the bryophytic flora vary—sometimes with strong changes within the space of a few centimeters. The question arises, then, how large an area must an aggregation of bryophytes

6 Moss nomenclature follows Grout, 1928 in so far as possible, otherwise Grout, 1903. Liverwort names follow Evans & Nichols, 1908 in the main. Macvicar, 1926 was also consulted. Some identifications and nomenclatural corrections were kindly made by Dr. A. J. Grout, Dr. Margaret Fulford, and Dr. LeRoy Andrews.

7 The "Bodenschicht" is the low cryptogamic layer on the soil surface.

occupy before it constitutes a bona fide community? How many species must be involved? What criteria must be employed to distinguish a bryophytic community from a chance colony of one species with or without a few associates?

It would seem that the same criteria must be applied in the recognition of bryophytic unions as in the recognition of other unions composed of herbs, shrubs, or trees. Certainly the concept of *minimal area* will be applicable. Braun-Blanquet (1932, p. 52) says, minimal area is "the smallest area which can contain an adequate representation of an association. . . . A community of plants requires for its normal development a minimum area and also upon this area a minimum number of plant species." To the concept of a more or less definite species assemblage should be added the requirement of a characteristic structure for the community. That is, there should be certain dominant species—those of high coverage and of high frequency. It does not seem that the mere presence (or absence) of certain species would form an adequate basis for community recognition and delimitation. A fairly high degree of dominance and a minimum homogeneity should also be required of a community whether it be an association or a simple union. Of necessity, these are qualities more than they are exact quantities. At least it is unwise to say that there must be a certain minimum number of species and certain required frequence and coverage percentages for the "dominant species" for there to be a community. Nevertheless, as exact an expression as possible of the attributes of community structure should be the goal of community description.

Sociological statistics should not be followed slavishly. There is no substitute for good judgment in such matters, and good judgment, of course, implies experience. We have not been able to decide such matters in all instances in the present study of the bryophytic unions of the red maple swamp forest. Some bryophytic unions have been recognized and studied by quadrats. Others are mentioned in the paper but have not been analyzed. No quadrat work was done on the corticolous communities. Certain other aggregations of one species, or of a very limited number of species with one strong dominant, were not analyzed. With respect to certain floristically very simple aggregations, it may be said that there is no more reason for ignoring their claim to recognition as a union than there would be in stating that an arborescent union of *Pinus rigida* is not a community. Other examples of simple unions of plants of one species (or essentially so) which may be mentioned by way of illustration are those of *Spartina alterniflora, Phragmites communis, Kalmia latifolia, Fagus sylvatica,* etc.

We have used quadrats of 1 sq. dm. area in series of 10 in this study of bryophytic unions. Sometimes the stands have been scarcely larger than this minimal area quadrat. More often the stands have been greatly in excess of the minimal area. If this seems like an exceedingly small area, consider that proportionately a quadrat of 1 sq. dm. for a union of *Dicranum flagellare* is about equal to a quadrat of 10,000 sq. m. (2.5 acres) for a tree union in which the trees are only 10 m. tall. Studies of minimum quadrat area for arborescent synusiae have revealed sizes between 50 and 400 sq. m. for most

types where several scattered quadrats are used in taking the sample. The total necessary sample area for arborescent unions is usually between 2,000 and 10,000 sq. m. Furthermore, the highly gregarious nature of mosses tends toward homogeneity and simplicity in bryophytic unions, consequently 1 sq. dm. quadrats are likely to be adequate for the study of most of them, especially if several patches are investigated.

It may be well to consider the liverworts and mosses of this phytocoenosis with respect to general occurrence at the stations and with respect to moisture relations before discussing the unions which they form. Tables 9 and 10 give such data for the liverworts and the mosses, respectively. The floristic lists show a range from 13 liverwort species at Third Lake to 21 at Massapequa, with a total of 28 species in the phytocoenosis. For mosses the total is 48 species, with 22 different kinds at Wyandanch and at Massapequa and 34 species at the Hauppauge station. The total number of bryophytes observed in the phytocoenosis was 75 with 52 at Hauppauge representing the largest number for any one station. The other four stations were close together with from 39 to 42 species each.

TABLE 9

Liverwort Species

	Presence at Stations					Presence	Moisture Relations									
							Aquatic		Wet			Moist			Dry	
	Hauppauge	Wyandanch	Third Lake	Santapogue	Massapequa		Submerged	Emerged	Wood	Peat	Soil	Wood	Peat	Soil	Bark	
Blepharostoma trichophyllum				x		1				x						
Calypogeia Trichomanis	x	x	x	x	x	5			x		x	x	x	x	x	
Cephalozia bicuspidata		x	x		x	3			x			x		x		
Cephalozia catenulata	x	x	x	x	x	5			x	x			x			
Cephalozia curvifolia	x	x			x	3			x	x	x					
Cephalozia connivens	x		x	x		3			x	x	x		x			
Cephalozia media	x	x	x	x	x	5			x	x	x		x			
Chiloscyphus rivularis	x					1	x									
Diplophyllum apiculatum					x	1			x					x		
Frullania Asagrayana	x				x	2									x	
Frullania Brittoniae					x	1									x	
Frullania eboracensis	x	x	x	x	x	4									x	
Geocalyx graveolens	x	x				2			x			x	x			
Lepidozia sylvatica	x	x	x	x	x	5			x	x	x		x			
Lophocolea bidentata	x	x				2			x							
Lophocolea heterophylla	x	x	x	x	x	5			x	x		x	x			
Nardia crenulata	x	x	x	x	x	5			x	x	x		x	x		
Odontoschisma prostratum			x	x	x	3			x	x	x		x			
Pallavicinia Lyellii	x	x	x	x	x	5			x	x	x		x			
Pellia epiphylla		x	x	x	x	4		x	x	x	x					
Porella platyphylla	x					1									x	
Porella platyphylloidea					x	1									x	
Ptilidium pulcherrimum	x	x	x	x	x	5						x			x	
Riccardia latifrons	x	x			x	3			x		x					
Riccardia multifida	x				x	2	x									
Riccardia palmata				x	x	2			x		x					
Scapania nemorosa		x			x	2			x		x			x		
Scapania undulata		x		x	x	3			x		x					
Number of species (28)	18	18	13	14	21		2	1	19	11	13	5	10	5	6	

TABLE 10

MOSS SPECIES

	Presence at Stations					Presence	Moisture Relations								
							Aquatic		Wet			Moist			Dry
	Hauppauge	Wyandanch	Third Lake	Santapogue	Massapequa		Submerged	Emerged	Wood	Peat	Soil	Wood	Peat	Soil	Bark
Amblystegium Juratzkanum	x		x	x	x	4			x	x					x
Aulacomnium palustre	x	x	x	x	x	5			x	x	x				
Brachythecium salebrosum	x	x				2			x	x		x			x
Brotherella recurvans			x	x		2						x	x		
Bryhnia Novae-Angliae	x	x	x			3			x		x				
Bryum capillare flaccidum	x					1		x			x				
Campylium radicale	x					1			x						
Catharinea crispa			x		x	2			x	x	x		x	x	
Catharinea undulata	x	x	x	x		4			x	x	x		x	x	
Climacium Americanum	x	x				2		x	x						
Climacium Kindbergii	x					1		x	x		x				
Dicranum flagellare	x	x	x	x	x	5						x	x	x	
Dicranum flagellare minutissimum	x	x	x	x	x	5							x		x
Dicranum montanum	x	x	x	x	x	5							x	x	x
Dicranum scoparium	x	x	x	x	x	5			x	x	x	x	x	x	
Entodon cladorrhizans	x					1			x						
Eurhynchium serrulatum	x					1									x
Fontinalis dalecarlica				x	x	2	x								
Fontinalis Sullivantii				x		1	x								
Georgia pellucida	x	x	x	x	x	5			x	x	x	x	x	x	x
Heterophyllum Haldanianum	x		x	x	x	4			x	x	x	x	x	x	x
Homomallium adnatum	x	x	x	x	x	5							x		x
Hygroamblystegium irriguum	x					1			x		x				
Hypnum cupressiforme					x	1						x			
Hypnum curvifolium		x			x	2			x	x					x
Hypnum imponens	x	x	x	x		4			x			x	x	x	
Hypnum reptile			x			1						x			
Leptodictyum riparium longifollium	x					1		x	x						
Leucobryum glaucum	x	x	x	x	x	5			x	x		x	x	x	x
Mnium affine ciliare	x					1								x	
Mnium cuspidatum	x					1						x	x	x	x
Mnium hornum	x	x	x	x	x	5			x	x	x	x			x
Mnium punctatum	x	x				2			x	x	x	x			
Mnium punctatum elatum	x	x	x			3		x			x				
Philonotis fontana	x		x	x	x	4		x	x		x				
Plagiothecium denticulatum			x			1						x	x	x	x
Plagiothecium latebricola			x			1									x
Plagiothecium micans		x		x	x	3					x	x	x		x
Plagiothecium striatellum	x		x			2							x	x	
Pohlia nutans			x	x		2								x	
Polytrichum ohioense			x			1							x	x	
Sphagnum capillaceum tenellum	x	x	x	x	x	5		x	x	x	x		x		
Sphagnum magellanicum	x	x	x	x	x	5		x	x	x	x		x		
Sphagnum palustre	x	x	x	x	x	5		x	x	x	x		x	x	
*Syrrhopodon texanus**				x		1							x		
Thelia hirtella				x	x	2						x			x
Thuidium delicatulum	x	x	x	x	x	5			x	x	x	x	x	x	x
Thuidium minutulum	x					1							x		
Number of species (48)	34	22	28	25	22		2	9	25	16	19	17	23	17	17

* See Cain, 1936b.

In previous tables we have given *frequency* data which are based on the use of several quadrats within a single stand of a community, and *constancy* data which are based on one quadrat per stand when several stands of the same community are sampled. Tables 9 and 10 give *presence* data which relate to the occurrence of a species in the phytocoenosis as a whole as found at each station, i.e. presence is based on the floristic lists from the entire stands and not on a limited sample area. Eight liverworts and 13 mosses had a presence of 5, that is, there were 21 species which occurred in all five stands of the red maple phytocoenosis which were studied. These species are *Calypogeia Trichomanis, Cephalozia catenulata, C. media, Lepidozia sylvatica, Lophocolea heterophylla, Nardia crenulata, Pallavicinia Lyellii, Ptilidium pulcherrimum* among the liverworts and *Aulacomnium palustre, Dicranum flagellare D. flagellare* var. *minutissimum, D. montanum, D. scoparium, Georgia pellucida, Homomallium adnatum, Leucobryum glaucum, Mnium hornum, Sphagnum capillaceum* var. *tenellum, Sp. magellanicum, Sp. palustre,* and *Thuidium delicatulum* among the mosses. Seven additional species have a presence of 4: *Frullania eboracensis, Pellia epiphylla, Amblystegium Juratzkanum, Catharinea undulata, Heterophyllum Haldanianum, Hypnum imponens,* and *Philinotis fontana.* The presence results are summarized in Table 11. It will be noticed that these presence class figures present a secondary peak in class 5 which includes the species of highest presence. This relationship is apparently similar to the phenomena revealed by frequency class and constancy class data.

TABLE 11

The presence class distribution of the bryophytes of the red maple phytocoenosis of Central Long Island.

Presence classes	Liverworts		Mosses		Liverworts and mosses	
	Species	Per cent	Species	Per cent	Species	Per cent
P 1	6	21.4	17	35.4	23	30.3
P 2	6	21.4	10	20.8	16	21.1
P 3	6	21.4	3	6.3	9	10.8
P 4	2	7.1	5	10.4	7	10.2
P 5	8	28.7	13	27.1	21	27.6
Total	28		48		76	

Tables 9 and 10 also show the general moisture relations of the bryophytes on a basis of the following classification:

Aquatic
  Submerged
  Emersed
Wet situations
  On wood
  On peat
  On soil
Moist situations
  On wood
  On peat
  On soil
Dry situations
  On bark.

More liverworts occur on wet wood than on any other substratum in this

phytocoenosis. Among the mosses more species are found on wet wood and moist peat than anywhere else.

Many species have a rather wide range of substrata which they occupy. Nine liverworts and 18 mosses grow on wood, peat, and soil. One liverwort *(Ptilidium pulcherrimum)* was found on both wood and bark. Fifteen of the 17 mosses on bark were also found on other substrata; only *Eurhynchium serrulatum* and *Plagiothecium latebricola* were found exclusively on bark. Five of the six liverworts on bark were not found on any other substratum (three species each of *Frullania* and two of *Porella*.) None of the four submersed aquatics was found in any other condition, while all of the 10 emersed aquatic mosses were found also on wet wood, peat, or soil, and sometimes on such substrata which could only be classed as moist, not wet.

There are, of course, fluctuations in the wetness of these substrata. Such indications as are given here of the moisture requirements of the species are based on observations made during two summers. It is not to be understood that these observations apply to the species elsewhere. We have merely attempted these indications of their water ecology on a basis of our present limited study.

TABLE 12

Bryophytic unions of the Aceretum, Central Long Island, exclusive of those on trees.

Dominant species of the union	Hauppauge	Wyandanch	Third Lake	Santapogue	Massapequa	Community Presence
Communities sampled by quadrats at one or more stations:						
Catharinea undulata	*10 quads*			noted*		2
Mnium hornum	*10 quads*	noted	*10 quads*	noted	noted	5
Dicranum flagellare	*10 quads*	noted	*10 quads*	noted	noted	5
Dicranum scoparium	*10 quads*	noted	*10 quads*	noted	noted	5
Nardia crenulata	noted	*10 quads*	noted	noted	noted	5
Lepidozia sylvatica		*10 quads*		noted		2
Sphagnum palustre	noted	noted	*10 quads*	noted	noted	5
Georgia pellucida	noted	noted	*10 quads*			3
Catharinea crispa			*10 quads*		noted	2
Communities not sampled by quadrats:						
Leucobryum glaucum	noted	noted	noted*	noted*	noted	5
Sphagnum capillaceum	noted	noted	noted	noted	noted	5
Cephalozia media	noted*	noted	noted	noted*	noted	5
Thuidium delicatulum	noted	noted		noted	noted	4
Aulacomnium palustre	noted*	noted*			noted*	3
Mnium punctatum elatum	noted	noted	noted*			3
Byrhnia Novae-Angliae	noted	noted*				2
Chiloscyphus rivularis	noted					1
Riccardia multifida	noted					1
Scapania undulata		noted			noted	2
Pellia epiphylla		noted	noted		noted	3
Number of communities	16	16	12	11	13	

* = Community fragmentary.

Table 12 presents a summary of our observations on the bryophytic unions of the red maple phytocoenosis. Nine different unions were sampled by quadrats at one or more stations. Five of these communities and three additional ones were present at all five stations for the phytocoenosis. Five other unions were observed or sampled at three or four stations. Altogether 20 unions are recognized (exclusive of the bryophytes on bark which will be considered later). Only two unions were observed at a single station. One-third of all unions recognized occurred at each station and 80 per cent of them occurred at both Hauppauge and Wyandanch.

TABLE 13

Sphagnum palustre union: Third Lake, wet soil

											Constancy	Coverage
Sphagnum palustre	5	5	5	5	5	5	5	5	5	5	100%	5
Aulacomnium palustre	x	x	1	x	x		x	x	x	x	90	x
Cephalozia media	x				x		x				30	x
Cephalozia connivens	x								x	x	30	x
Thuidium delicatulum										x	10	x
Pellia epiphylla										x	10	x
Number of species												6

TABLE 14

Nardia crenulata union: Wyandanch, moist peat.

											Constancy	Coverage
Nardia crenulata	5	5	5	5	5	5	4	4	4	4	100%	5
Dicranum flagellare	1	2	2	x	3	3	3	x	3	3	100	2
Lepidozia sylvatica	1	2	x	x	2	–	x	1	x	–	80	1
Cephalozia media	x	x	x	–	x	–	x	–	x	x	70	x
Leucobryum glaucum	x	–	–	–	–	x	–	–	1	x	40	x
Pallavicinia Lyellii	x	–	1	–	–	–	x	–	–	–	30	x
Aulacomnium palustre	x	–	–	–	–	x	–	x	–	–	30	x
Georgia pellucida	x	–	–	–	–	–	x	–	–	–	20	x
Sphagnum palustre	x	–	–	–	–	–	–	–	–	–	10	x
Dicranum scoparium	–	–	–	2	–	–	x	–	–	–	20	1
Number of species												10

TABLE 15

Georgia pellucida union: Third Lake, moist peat.

											Constancy	Coverage
Georgia pellucida	4	5	5	5	4	5	5	5	4	5	100%	5
Dicranum flagellare	3	–	–	1	3	2	1	2	2	2	80	2
Pallavicinia Lyellii	x	x	x	1	–	1	–	–	x	x	70	x
Catharinea crispa	1	1	–	–	–	–	–	–	2	x	40	1
Cephalozia media	x	x	–	–	–	–	–	–	–	–	20	x
Nardia crenulata	x	–	–	–	–	–	–	–	–	–	10	x
Cephalozia connivens	–	x	–	x	x	x	–	x	x	–	60	x
Mnium hornum	–	x	–	–	–	–	–	–	–	–	10	x
Aulacomnium palustre	–	–	2	–	–	–	–	x	–	–	20	1
Sphagnum palustre	–	–	x	–	–	–	–	x	–	–	20	x
Catharinea undulata	–	–	x	–	–	–	–	–	–	–	10	x
Leucobryum glaucum	–	–	–	–	–	–	–	–	–	1	10	x
Number of species												12

TABLE 16

Catharinea undulata union: Hauppauge, wet soil.

											Constancy	Coverage
Catharinea undulata	5	5	5	4	5	5	5	5	5	5	100%	5
Mnium hornum	x	2	2	–	–	–	x	1	–	–	50	1
Pallavicinia Lyellii	x	–	–	–	–	–	–	–	–	–	10	x
Mnium affine ciliare	–	2	–	3	2	–	–	–	1	–	40	2
Heterophyllum Haldanianum	–	–	–	x	–	–	–	–	–	–	10	x
Number of species												5

TABLE 17

Catharinea crispa union: Third Lake, wet soil.

											Constancy	Coverage
Catharinea crispa	5	5	5	5	5	5	4	4	5	5	100%	5
Sphagnum magellanicum	x	–	–	–	–	–	–	–	–	–	10	x
Aulacomnium palustre	–	2	x	–	1	x	1	1	–	–	60	1
Pallavicinia Lyellii	–	2	2	1	–	x	x	–	–	–	50	1
Georgia pellucida	–	–	x	1	2	3	2	1	–	–	60	2
Dicranum montanum	–	–	x	–	–	–	1	x	–	–	30	x
Mnium hornum	–	–	–	1	–	–	–	–	2	1	30	1
Dicranum flagellare	–	–	–	–	x	1	–	1	–	–	30	x
Cephalozia media	–	–	–	–	x	x	–	x	–	–	30	x
Cephalozia connivens	–	–	–	–	–	–	x	–	–	–	10	x
Calypogeia Trichomanis	–	–	–	–	–	–	–	x	–	–	10	x
Thuidium delicatulum	–	–	–	–	–	–	–	–	2	2	20	1
Amblystegium Juratzkanum	–	–	–	–	–	–	–	–	1	–	10	x
Number of species												13

TABLE 18

Mnium hornum union: Hauppauge, wet peat.

											Constancy	Coverage
Mnium hornum	5	5	5	5	5	5	5	5	5	5	100%	5
Pallavicinia Lyellii	1	x	–	1	x	–	1	x	–	–	60	x
Georgia pellucida	1	x	–	–	–	–	–	–	–	–	20	x
Calypogeia Trichomanis	x	x	–	–	–	–	–	–	–	–	20	x
Dicranum flagellare	2	–	–	–	–	–	–	–	–	–	10	1
Cephalozia connivens	x	–	–	–	–	–	–	–	–	–	10	x
Lepidozia sylvatica	x	–	–	–	–	–	–	–	–	–	10	x
Catharinea sylvatica	–	–	–	2	–	–	–	x	–	2	30	1
Thuidium delicatulum	–	–	–	x	–	–	–	–	–	–	10	x
Number of species												9

TABLE 19

Dicranum scoparium union: Hauppauge, wet soil

											Constancy	Coverage
Dicranum scoparium	4	5	5	5	5	5	5	5	5	5	100%	5
Nardia crenulata	1	x	–	–	–	–	1	x	–	x	50	x
Pallavicinia Lyellii	x	–	–	–	–	2	–	–	–	–	20	1
Georgia pellucida	1	–	–	–	–	x	–	–	–	–	20	x
Dicranum flagellare	1	–	–	–	–	–	–	–	–	–	10	x
Lepidozia sylvatica	x	–	–	–	–	–	–	–	–	–	10	x
Hypnum imponens	–	–	–	x	1	–	–	–	–	–	20	x
Sphagnum capillaceum	–	–	–	–	2	–	–	–	–	–	10	1
Mnium cuspidatum	–	–	–	–	–	–	1	–	–	–	10	x
Sphagnum palustre	–	–	–	–	–	–	–	1	x	x	30	x
Number of species												10

TABLE 20

Dicranum flagellare union: Third Lake, moist peat.

											Constancy	Coverage
Dicranum flagellare	4	5	5	5	5	5	5	5	5	4	100%	5
Georgia pellucida	2	1	1	x	x	–	–	–	2	–	60	1
Cephalozia connivens	1	x	x	–	–	x	–	x	x	–	60	x
Leucobryum glaucum	x	–	–	x	2	–	–	–	–	2	40	1
Pallavicinia Lyellii	2	–	–	–	–	–	–	–	x	–	20	1
Cephalozia bicuspidata	x	x	–	–	–	–	–	–	–	–	20	x
Nardia crenulata	–	1	–	x	–	–	–	1	–	–	30	x
Cephalozia media	–	x	–	–	x	x	–	–	–	–	30	x
Catharinea crispa	–	1	–	–	–	–	–	–	–	–	10	x
Aulocomnium palustre	–	–	1	–	–	1	–	–	x	–	30	x
Sphagnum palustre	–	–	x	–	–	–	–	–	x	–	20	x
Dicranum montanum	–	–	–	x	–	–	–	–	–	–	10	x
Lepidozia sylvatica	–	–	–	–	x	–	–	x	–	–	20	x
Hypnum imponens	–	–	–	–	x	x	–	–	–	–	20	x
Dicranum scoparium	–	–	–	–	x	–	–	–	x	–	20	x
Cephalozia catenulata	–	–	–	–	–	x	–	–	–	–	10	x
Number of species												16

TABLE 21

Lepidozia sylvatica union: Wyandanch, wet peat.

											Constancy	Coverage
Lepidozia sylvatica	4	4	5	4	4	5	5	5	5	5	100%	5
Cephalozia media	2	x	1	2	1	x	1	x	x	1	100	1
Nardia crenulata	1	–	x	x	–	–	–	x	1	x	60	x
Pallavicinia Lyelli	2	–	x	–	–	–	–	–	x	–	30	1
Dicranum scoparium	1	–	1	–	–	–	–	–	–	–	20	x
Leucobryum glaucum	–	x	–	–	1	1	x	x	–	x	60	x
Sphagnum palustre	–	1	1	2	x	–	–	–	–	–	40	1
Aulacomnium palustre	–	1	x	2	–	–	–	–	–	–	30	1
Dicranum flagellare	–	–	–	–	4	–	x	–	–	x	30	2
Georgia pellucida	–	–	–	–	–	x	–	1	–	–	20	x
Calypogeia Trichomanis	–	–	–	–	–	–	x	x	x	x	40	x
Number of species												11

Tables 13-21 show the results of the statistical analysis of nine unions. In every case 10 quadrats of 1 sq. dm. were used. No stand of a union was sampled by more than one quadrat. In each case the quadrat was placed well within the stand to avoid marginal influence. The number of species in a union ranged from 5 for the union of *Catharinea undulata* to 16 for the union of *Dicranum flagellare*. In every case a single species was definitely dominant with a frequency of 100 per cent and a coverage in class 5. Sometimes associated species attained a frequency of 90 or 100 per cent or a coverage in class 1 or 2. In no instance, however, was the dominance of a community by a single species in doubt.

General observations on the corticolous bryophytes were made at each station. At three stations, Massapequa, Third Lake, and Happauge, detailed examinations were made of fifteen trees for the purpose of ascertaining the bryophytes on the tree trunks and some idea of their distribution. The results

are summarized in Table 22. The trees examined were approximately of the same size, averaging about 1 ft. d.b.h. Many of the trunks were leaning and in the case of trees standing on the stream bank they were J-shaped, or pistol-butted. A concentration of bryophytes was more often found on the upper side of leaning trees although several times the trees had equally numerous plants on the underneath regions. At the base of the trunks (0.3-0.5 m.) there was usually a fairly danse stands of mosses, sometimes a closed cover.

TABLE 22

Summary of observations on corticolous mosses on trunks of five trees at each of three stations.

	Tree speices and stations where bryophytes were observed			Exposure Distribution
	Massapequa	Third Lake	Hauppauge	
Frullania Brittoniae	Acer	Fraxinus	Quercus	*N* E S W
Frullania eboracensis	Acer			*N* E S W
Dicranum flagellare var. *minutissimum*	Acer	Acer	Acer, Quercus	*N* E S W
Dicranum montanum	Acer	Acer	Acer	*N* E S W
Homomallium adnatum	Acer	Fraxinus, Acer	Acer	*N* E S W
Thelia hirtella	Acer, Quercus		Nyssa, Quercus	*N* E S W
Ptilidium pulcherrimum	Acer, Quercus	Acer		N W
Frullania Asagrayana	Acer		Acer	N E S W
Porella platyphylloidea	Acer			*N* E
Thuidium delicatulum	Quercus	Fraxinus	Acer, Quercus, Nyssa	*N* W
Mnium hornum	Acer, Quercus	Fraxinus		*N* E S
Lophocolea heterophylla	Acer	Acer	Acer	N E S W
Leucobryum glaucum	Quercus			N
Heterophyllum Haldanianum	Acer	Acer		N E S W
Plagiothecium micans		Acer		N E S W
Porella platyphylla			Acer	N
Nardia crenulata			Acer	N E S W
Amblystegium Juratzkanum			Quercus	N E
Mnium cuspidatum			Quercus, Nyssa	N E
Brachythecium salebrosum			Quercus	N E S W
Dicranum flagellare			Acer	N E S W
Georgia pellucida			Acer	N E S W
Hypnum curvifolium	Acer			N E

Certain species were found only low on the trunks. This list includes the following:

Species	Maximum height	Species	Maximum height
**Thuidium delicatulum*	50 cm.	**Mnium cuspidatum*	15 cm.
**Mnium hornum*	45 cm.	**Hypnum curvifolium*	15 cm.
**Leucobryum glaucum*	25 cm.	*Dicranum flagellare*	5 cm.
Nardia crenulata	25 cm.	*Georgia pellucida*	5 cm.

Of these eight species five, those marked by an asterisk, form definite communities of 0.1 sq. m. area or more. These are essentially terrestrial species and communities and their presence on bark is attributable to the accumulation of some inorganic sediment (water and dust deposited) and to favorable moisture conditions. In some patches there is a definite layer of peat a few millimeters thick on the bark surface which helps hold moisture. This organic material has developed from the mosses themselves, some of it undoubtedly from species which preceded the present dominants. Three additional species found only on the lower part of the trunks are: *Porella platyphylla* (up to 50 cm.), *Amblystegium Juratzkanum* (up to 30 cm.), and *Brachythecium salebrosum* (up to 15 cm.).

Another group of species was found to occur at considerably greater heights on the trunks. They are listed below:

Species	Maximum height	Species	Maximum height
Frullania Brittoniae	240 cm.	*Heterophyllum Haldanianum*	200 cm.
Frullania eboracensis	225 cm.	*Homomallium adnatum*	185 cm.
Dicranum flagellare var. *minutissimum*	225 cm.	*Thelia hirtella*	150 cm.
Dicranum montanum	225 cm.	*Lophocolea heterophylla*	150 cm.
Ptilidium pulcherrimum	220 cm.	*Frullania Asagrayana*	100 cm.
		Porella platyphylloidea	85 cm.

These species which occur highest up the trunks also occur down to 50 cm. and frequently to the soil line. For any one species the maximum height attained is in the dampest (most protected) situations of the trunks.

Something of the distribution of the bryophytes may be seen from the following considerations. The numerators of the following fractions equal the number of species found on the exposure, the denominator indicates the total number observed on all bark exposures: N 23/23, E 18/23, S 15/23, W 16/23, NESW 14/23. It is seen that the north exposure averages slightly more favorable for bryophytes. Among the other sides there are only slight differences. Vertical occurrence of species is shown in the following list which gives the number of species by height belts:

0– 25 cm.	16 species	125–150 cm.	9 species
25– 50 cm.	18 species	150–175 cm.	8 species
75–100 cm.	11 species	175–200 cm.	6 species
100–125 cm.	10 species	200–225 cm.	5 species

It is obvious that the number of species which can grow successfully on bark is correlated with height above the soil inasmuch as there is a steady reduction in number of species with height above ground. This is probably a moisture correlation. The slightly smaller number of species in the lowest belt may be attributable to the greater competition for space since certain of the species tend to grow in pure stand.

Bryophytes seem to get their start on the bark in the sinuses between ridges or scales and then spread longitudinally with greater rapidity than laterally. This would seem to be due to the following factors: more dust lodges

in the cracks, the cracks are more protected from drying, more water drains down the cracks than the ridges and hence they are moist for longer periods of time. Many of the mosses of the basal part of the trunks have spread on to the bark from patches on the adjacent soil.

Of the 11 species which grow on the trunks above the soil influence (mostly between 0.5 and 2.5 m.), eight of them have coverages of class 5 in local regions of 1 sq. dm. or more. Despite this situation it appears that only a single synnusia should be recognized for this region. The most widely distributed and abundant species are *Dicranum flagellare* var. *minutissimum* and *Homomallium adnatum*. Wilson (1936) described the corticolous moss communities of a Central Indiana Woods. One of her "associations" was *Homomallietum adnatum*, the most xerophytic of the series studied. She erects a federation, *Homomallion adnatum*, which includes 5 other communities beside the one which gives name to the federation. Until bark communities are studied more widely we may as well add the present union to the group erected by Wilson, although floristically they do not compare except for the "key" species, and the phytocoenoses to which they belong are widely different.

Some rather intensive bryocoenological work has been done by Cain and Sharp[8]. Billings and Drew[8] have worked on the habitat relations of certain of the corticolous communities of the same region. From the foregoing work it appears that bryophytic unions can be classified to advantage on a basis including both floristics and ecology. In the present paper, however, it seems wiser to allow the matter of the interrelations of the unions to pass until more studies have been made.

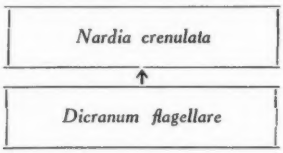
Certain mosses may be dominant on the peat stools (hummocks) of the wetter parts of the *Aceretum*, as at Third Lake. The following list gives these species in order of increasing water requirement:

Dicranum montanum
Georgia pellucida
Dicranum flagellare
Leucobryum glaucum
Dicranum scoparium
Aulacomnium palustre
Sphagnum palustre
Thuidium delicatulum.

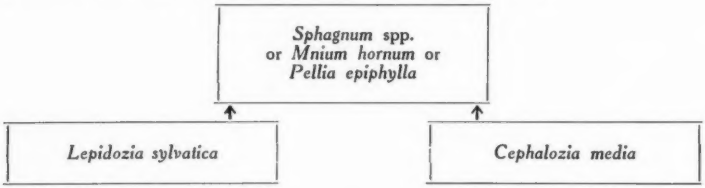
As a consequence of these general relations one finds a certain distribution of moss unions on the stools. For example, on a bank or low stool (20-25 cm. high) next to water the lower and less steep slopes will frequently be occupied by *Thuidium* or *Sphagnum* while the top is commonly occupied by *Dicranum scoparium*. On taller stools, frequently with vertical sides (50 cm. high), the top is commonly occupied by *Georgia pellucida* while the lower slopes have *Catharinea* extending from 20-25 cm. down to the saturated soil over which it may extend for a considerable area. On other stools the top may be covered by *Dicranum montanum* or *Leucobryum*, the shoulders and sides by *Dicranum flagellare* or *Georgia*, and the lower slopes by *Mnium hornum*, *Catharinea crispa* or species of *Sphagnum*.

8 These data are in manuscript form but may be expected to appear in print during 1938 in this Journal.

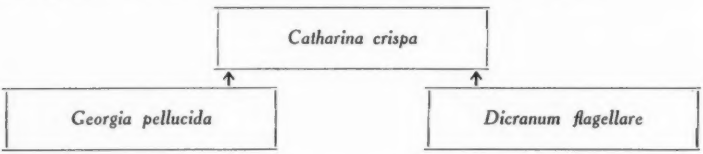
Certain successional relations were observed among the bryophytic unions. For example, at Wyandanch, *Dicranum flagellare* communities were overgrown by *Nardia crenulata* which gradually increased its coverage in places to the extent that the former lost its dominance and was largely exterminated.



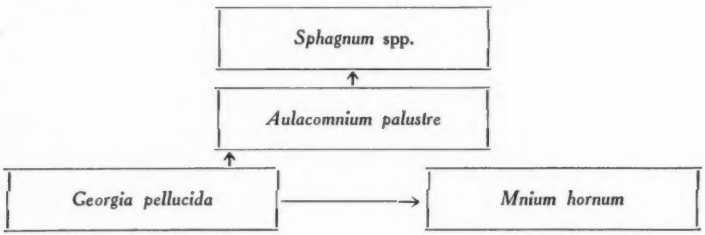
Also at Wyandanch and at Third Lake it was observed that new banks quickly become covered by *Lepidozia sylvatica* and *Cephalozia media* which are replaced by *Pellia epiphylla, Mnium hornum,* or *Sphagnum* spp.



Catharinea crispa under certain conditions can compete successfully with *Georgia* and *Dicranum flagellare* and can ultimately dominate them.



Where, for any reason, the moisture content of the peat stools increases, either by local impeded drainage or by the reaction of the mosses themselves, *Georgia pellucida* may give way to other species as indicated below:



Miscellaneous Considerations

Two groups of plants not strictly a part of the *Aceretum rubri* are of sufficient interest to deserve some consideration. In the first place there are certain aquatic plants of the streams of the *Aceretum* which are not related to that phytocoenosis any more than they are to several others. Second is a consideration of a low shrub community which is ecotonal to the *Aceretum* and the adjacent *Pinetum*.

Inasmuch as the red maple phytocoenosis occurs along streams and more or less in and about impounded waters, it may be well to mention briefly some of the aquatic and amphibious plants associated with the unions which are considered in more detail. Where the phytocoenosis borders ponds there are usually certain zones, between the open water and the woods, which represent stages in succession. The succession may pass through either marsh stages or bog mat stages. In either case the woods are typically bordered by a narrow zone of shrubs which can tolerate considerable inundation. Many of the species of the *Clethro-Azalea* union, described as a layer community under the trees, enter into the composition of this shrub margin.

In the small, shallow, slow-flowing streams which penetrate the phytocoenosis are certain typical aquatic herbs: *Castalia odorata, Nymphaea advena, Potamogeton epihydrus, P. pusillus, Persicaria hydropiperoides, Scirpus subterminalis, Juncus acuminatus, Chrysosplenium americanum, Callitriche palustris, Sparganium simplex* (?), and *Glyceria pallida*. Several species of amphibious plants are frequently found, sometimes in the water and sometimes along the banks of the streams: *Bidens discoidea, Carex atlantica, C. crinita, C. lurida, C. stricta, Drosera rotundifolia, Dulichium arundinaceum, Glyceria canadensis, G. melicaria, G. striata, Juncus effusus, Lycopus virginicus, Lysimachia producta, Scirpus cyperinus, Sparganium eurycarpum,* and *Triadenum virginicum*. A considerable number of these species were found nowhere but in and at the margins of the streams, but some of them were sampled well within the phytocoenosis as is shown in Table 5.

Conard (1935, p. 495) described a low shrub association dominated by *Gaylussacia dumosa* and occurring on somewhat marshy ground between the *Aceretum* and the *Pinetum* at Santapogue. This community is also closely related to his community no. 42, *Vaccinietum corymbosi*, which may occupy similar situations. He states that both these communities also occur in the pine barrens region of New Jersey. We have investigated Conard's station for the low shrub community by means of 17 quadrats each of 4 sq. m. scattered in a line through the center of the stand. Our results do not agree entirely with the more general description of Conard. We find that *Gaylussachia dumosa* is not more than a codominant with *Myrica carolinianum* and *Kalmia angustifolia*, rather than the sole dominant of the community, Table 23. Our sampling of the community is certainly adequate since no species of coverage above class 1 (1-5 per cent) was added to the series after the sixth quadrat, and no new species was added to the floristic assemblage after the

thirteenth quadrat. In addition to the species sampled by the quadrats, four woody plants were observed: *Smilax rotundifolia, Toxicodendron Vernix, Alnus rugosa,* and *Viburnum dentatum.* Only the two herbs in direct competition with the shrubs were sampled statistically. Ten additional species were observed in the community: *Doellingeria umbellata, Lilium philadelphicum, Polygala lutea, Blephariglottis Blephariglottis, B. ciliaris, Lorinseria areolata, Panicum Bicknellii, Drosera rotundifolia, Eupatorium verbaenifolium,* and *E. perfoliatum.* Of these 14 species, six have their strongest affinities with the *Aceretum.* Of the 42 species in the community, 18 have undoubted affinities with the *Aceretum* and 20 with the *Pinetum,* or at least with the pine barrens in a broader sense.

This is an ecotonal community of considerable stability. Both the *Pinetum rigidae* and the *Aceretum rubri* are associations of an edaphic climax nature, in the sense of Nichols. This shrub community may also be an edaphic cli-

TABLE 23

The low shrub community contiguous to the Aceretum at Santapogue. Sampled by 17 quadrats, each of 4 sq. m.

Species	Frequence	Dominance class	Affinities Aceretum		Pinetum
Myrica carolinianum	94	3			x
Kalmia angustifolia	100	2	x	?	x
Gaylussacia dumosa	76	2			x
Aronia melanocarpa	76	1	x		
Gaylussacia frondosa	70	1			x
Gaylussacia baccata	48	1			x
Ilex glabra	48	1			x
Viburnum cassinoides	36	1	x		
Smilax glauca	76	x	x	?	x
Gaultheria procumbens	60	x			x
Azalea viscosa var. *glauca*	48	x	x		
Eubotrys racemosa	36	x	x		
Clethra alnifolia	24	x	x		
Azalea viscosa	12	x	x		
Rubus hispidus	12	x	x		
Vaccinium vicinum	6	x	x		
Aronia atropurpurea	6	x	x		
Neopieris mariana	6	x			x
Xolisma ligustrina	6	x			x
Herbs competing directly with the shrubs.					
Pteridium latiusculum	100	1			x
Osmunda cinnamomea	36	x	x		
Trees transgressive in the shrub community.					
Amelanchier canadensis	64	1	x		
Nyssa sylvatica	36	x	x	?	x
Betula populifolia	36	x			x
Sassafras variifolium	30	x			x
Pinus rigida	24	x			x
Acer rubrum var. *tridens*	6	x	x		x
Quercus alba	6	x	x	?	

max on sites in the pine barrens region which are intermediate in nature between the two woody phytocoenoses mentioned. Whether development in the future is in the direction of the *Aceretum* or of the *Pinetum* depends on changes in soil moisture which may take place. The nearby stream which is lined by the *Aceretum* is so near sea level and of such a low gradient, it is unlikely that there will be sufficient drainage to permit the capture of the shrub community by the *Pinetum*. Further impeded drainage, on the other hand, will favor the *Aceretum*, of course.

It is a pleasure to acknowledge the kind help of Dr. A. J. Grout, of The Biological Laboratory, in the identification and checking of certain mosses; Dr. Margaret Fulford, The University of Cincinnati, for similar assistance with the liverworts; and Dr. LeRoy Andrews for Sphagnum.

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CONTRIBUTION, DEPARTMENT OF BOTANY, N.S. NO. 20,
UNIVERSITY OF TENNESSEE,
KNOXVILLE, TENN.
AND
TULANE UNIVERSITY,
NEW ORLEANS, LA.

The Leaf and Stem Anatomy of Cornus florida in Relation to Light Exposure

Claudine Kaps Shank

I.—Introduction

In the Cincinnati region *Cornus florida* is normally a tree of the understory in the mixed mesophytic forest. In its common habitat this species reaches a height of fifteen to forty feet with a rather flat-topped crown on a trunk which ascends six to ten feet before branching. The maximum diameter of trunk attained is about eighteen inches with an average diameter of twelve inches.

On an area of formerly cleared ground near Quinn Road in the western part of Brown County, Ohio, *Cornus florida* is the dominant tree in a *Danthonia spicata-Cladonia* meadow. There this species has a round full form produced by a very prolifically branched crown on a short trunk. Mature trees in this area reach an average height of thirty feet, while the trunks seldom ascend over two feet before branching occurs. In this region it is unusual to see this species, commonly thought of as preferring shade, growing so abundantly in a meadow and presenting this contrast in appearance from the woodland individuals.

Since these great differences occur between the two groups of trees as a whole, it is probable that differences in leaves and twigs occur. It has been the purpose of this work to investigate the differences as they occur between leaves and twigs from the trees in the woods and in the open and between the same parts on the north and south sides of the trees in the open.

The writer is indebted to Dr. E. Lucy Braun for suggesitions and aid during the course of this work.

II.—Leaf Anatomy

A. Methods

In order to select leaves of all three types, from the trees in the woods and from the north and south sides of trees in the open, which approached the average condition for each exposure, leaves were picked from the corresponding sides of trees in the open and from various parts of the crowns of the trees in the woods. In each case ten trees were used in the selection. Five hundred leaves were picked in each of these selections and the leaves were dropped in a bucket of water. Then from each of these groups of five hundred leaves, fifty were selected at random and placed in a killing solution of formalin and alcohol. Thus one hundred and fifty leaves were preserved representing twenty trees, ten from the woods and ten from the meadow.

From these leaves quarter inch strips were cut from tip, basal, and mid-sections along the first lateral veins at a distance of one half inch from the midvein. Finally, slides were made for each of the hundred and fifty leaves.

The leaf sections were measured using a magnification of forty-four diameters and an eyepiece micrometer. The measurements were tabulated for the following: upper epidermis, palisade, spongy parenchyma, lower epidermis and total leaf thickness. Ten sets of measurements were made for each leaf, a total of 4,500 measurements. The averages were then calculated for each leaf and an average made for each of the three groups of leaves.

An additional fifty leaves from the woods and the open were collected, pressed, and blue-printed in order to make leaf area calculations.

B. Comparative Leaf Anatomy

The results of this study have been presented in the form of graphs in every possible case. The range of total thickness has been plotted for the three groups of leaves as one set of graphs. The depths of the separate tissues, too, are recorded graphically for each leaf group and presented in sets of three.

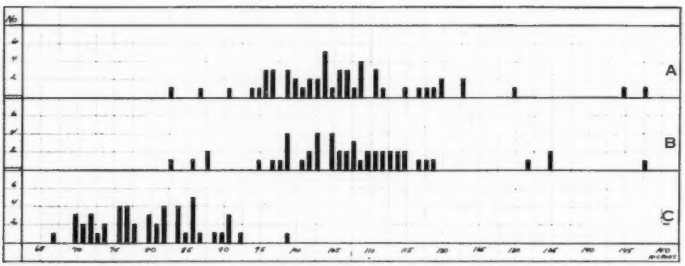

Fig. 1. Total Leaf Thickness.
A. Leaves from south side of trees in open meadow.
B. Leaves from north side of trees in open meadow.
C. Leaves from trees in woods.
(No. indicates the number of individual leaves of the thickness indicated.)

Fig. 1, of average total leaf thickness, shows that there is little if any difference between leaves from the north and south sides of trees in the open, although the tabulated actual averages gave a slightly higher average (3 μ.) for the leaves from the north side. On the other hand, both fig. 1 and the actual averages show a noticeable difference between leaves from the open and those from the woods, those from the woods being thinner. In fact there is little overlap between the range of thickness of leaves from the woods and those from the open. Similarly, figs, 2, 3, 4, and 5, of the separate tissues, indicate little difference between leaves from the north and south sides of trees

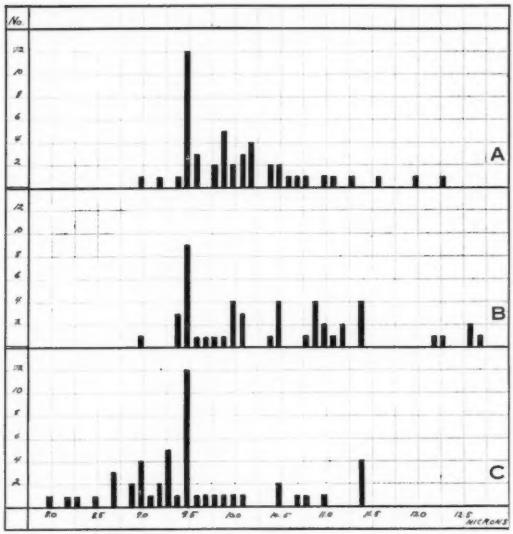

Fig. 2. Thickness of Upper Epidermis.
A, B, and C as in Fig. 1.

in the open, but in each case the corrsponding tissue of the leaves from the woods is conspicuously thinner.

Fig. 6, representing the percentage of palisade to total thickness for the 150 leaves throughout the three groups, shows that again the leaves from the north and south sides of trees in the open are much the same. In the greatest number of leaves in each group 24% of the total thickness of the leaf is occupied by palisade. For leaves from the woods the corresponding percentage is 20.

Data based on small collections of leaves made in a drought year, 1934, indicate that leaves on the south side of trees in the open were thicker than those from the north side. Average measurements show that all of the three groups of leaves were thicker in 1934 than in 1935. Comparisons of averages follow:

	1934	1935
Leaves from south open	162μ	107μ
Leaves from north open	135μ	110μ
Leaves from woods	95μ	86μ

Leaves collected representing these three groups in 1934 were so distinct

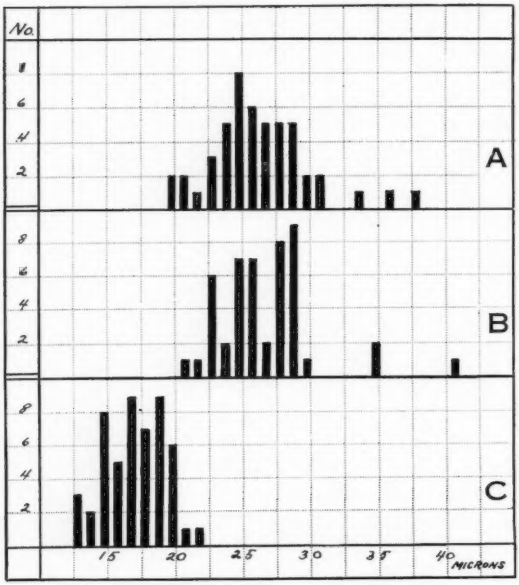

Fig. 3. Thickness of Palisade Parenchyma.
A, B, and C as in Fig. 1.

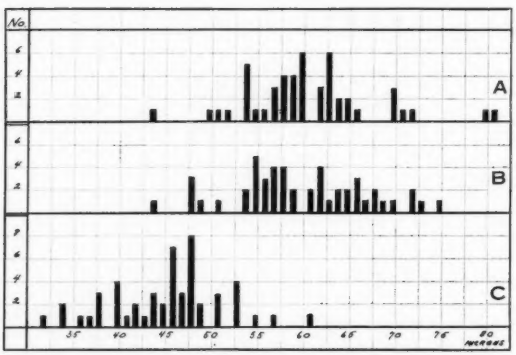

Fig. 4. Thickness of Spongy Parenchyma.
A, B, and C as in Fig. 1.

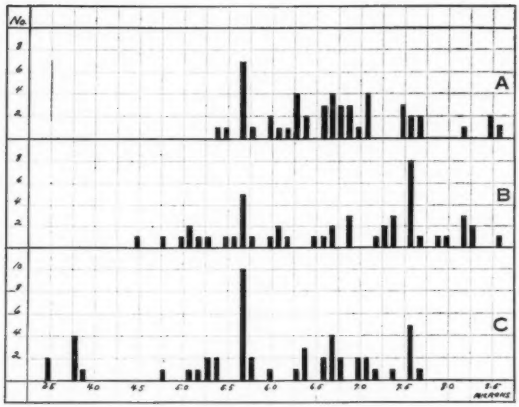

Fig. 5. Thickness of Lower Epidermis.
A, B, and C as in Fig. 1.

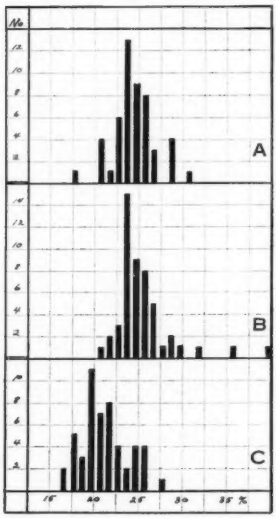

Fig. 6. Percentage of Palisade to Total Leaf Thickness.
A, B, and C as in Fig. 1.

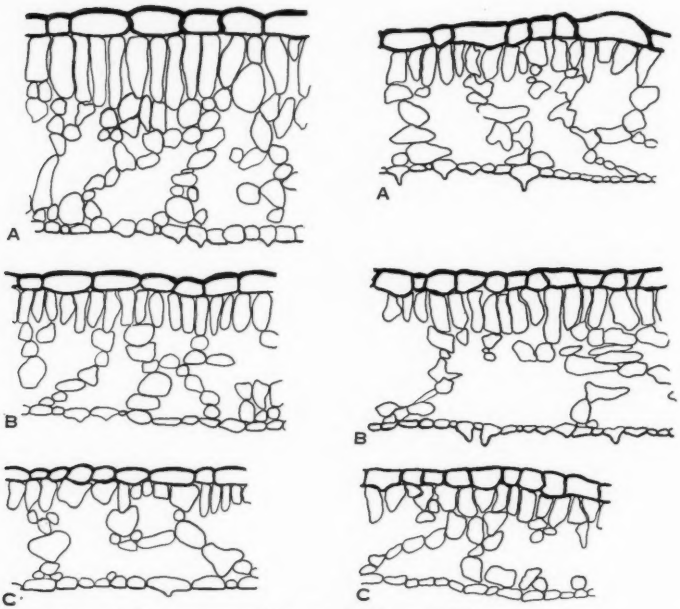

Fig. 7. Typical Cross-sections of Leaves of 1934 and 1935.
Figures at the left are of leaves form 1934, corresponding figures at the right are of leaves from 1935.

A, 1934, leaf from south side of tree in open; actual thickness, 161.5μ.
B, 1934, leaf from north side of tree in open; actual thickness, 112.5μ.
C, 1934, leaf from tree in woods; actual thickness, 89.7μ.
A, 1935, leaf from south side of tree in open; actual thickness 111.4μ.
B, 1935, leaf from north side of tree in open; actual thickness 110.7μ.
C, 1935, leaf from tree in woods; actual thickness 86.2μ.

as to their ranges of thickness that given an unmarked slide the writer feels reasonably certain that a casual microscopic observation would make possible almost immediate placement into the proper group. Fig. 7 shows typical cross-sections of the leaves from both years.

C. Discussion of Leaf Anatomy Data

Since the results of the 1934 investigation indicate such definite demarcations between the leaf groups, especially significant being the differences between those leaves from the north and south sides of trees in the open, and since this difference is not apparent in the 1935 results, some explanation is necessary.

First of all, results based on too few numbers are not likely to represent the average condition. It is obvious that if from the fifty leaves selected for each group in the final work ten were the number to be actually worked with, the results might be quite different. In order to test this, however, the sets of data secured in 1935 were shuffled about and groups of ten were selected at random in an attempt to approximate the results in 1934, but after twenty such random selections not one set gave anything like the range of averages obtained with the 1934 material. It is not likely then, that the difference in number of leaves selected is entirely responsible for the discrepancies in the two sets of results.

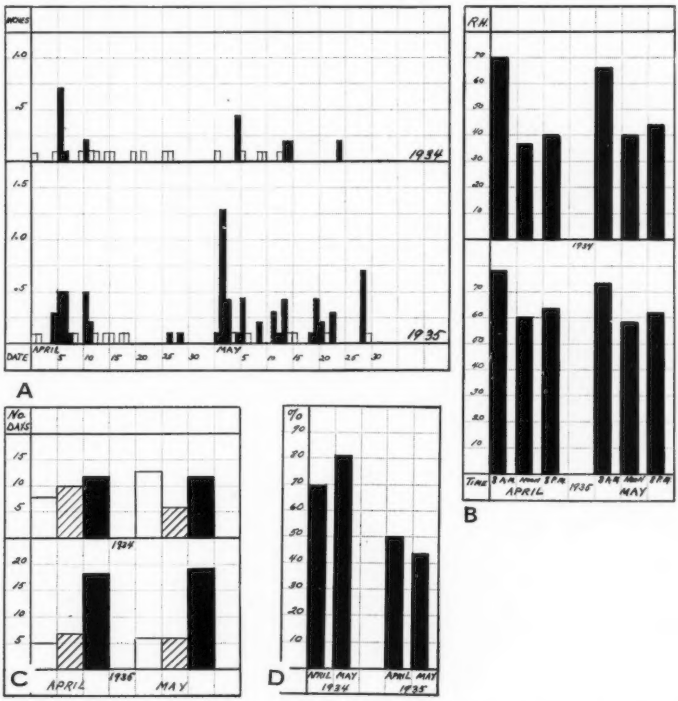

Fig. 8. Weather Data for April and May of 1934 and 1935 in the Cincinnati Region.

A. Daily precipitation.
B. Average relative humidity.
C. Light conditions. The open bars indicate clear days; the shaded bars, partly cloudy days; the solid bars, cloudy days.
D. Percentage of possible sunlight.

Secondly, weather records for the area concerned (Fig. 8) show that the spring of 1934 was drier than that of 1935 so that less humid conditions may have produced more variation even of leaves on the same tree, whereas in the more humid spring of 1935 the conditions were such that the differences in light intensity and relative humidity, on the north and south sides of the same tree were so little that there was a consequent lack of difference in leaf thickness from one side to the other although variation did occur throughout the tree. More humid conditions in the leaf formation period then, are interpreted as having a levelling-off effect as far as any gross differences from the north to the south side of the individual tree is concerned.

Fig. 8A, of daily precipitation in the months of April and May for both years, shows that the last two weeks in April and the whole of May had 4.1 inches or 472% more rain in 1935 than in 1934. Fig. 8B, of relative humidity for the two months indicates a higher average relative humidity for 1935 at all times. Similarly, the graph plotting the number of clear, partly cloudy,

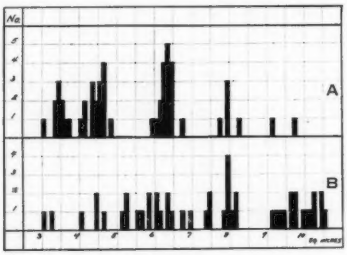

Fig. 9. Leaf Area.
A. Leaves from the open meadow.
B. Leaves from the woods.

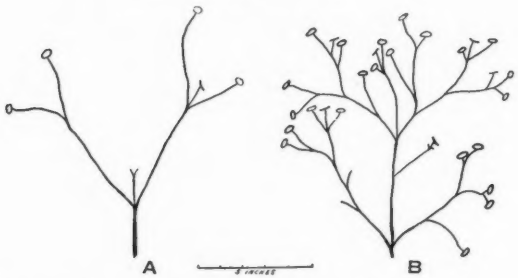

Fig. 10. Twig and Branching Arrangement of *Cornus Florida*.
A. Typical branch from the woods.
B. Typical branch from the open meadow.
(Ovals indicate flower buds; T's indicate dried receptacles and flower stalks from the previous season.)

and cloudy days for the two months (Fig. 8C) shows a great preponderance of cloudy days in 1935. Records show that 1934 had 59% more possible sunlight for April and May than 1935 (Fig. 8D). It is clear then, that the formative period for leaves in 1935 was in strong contrast to the same period in 1934; that the difference was one of greater precipitation, higher relative humidity, and less sunlight in 1935. In view of these seasonal differences and the fact that repeated selections of groups of ten leaves from the 1935 collections gave at no time averages that approximated those found for similar numbers in 1934, it is concluded that from year to year there are noticeable fluctuations in the average thickness of leaves, both in the open meadow and in the forest, and more than that, in years of less humid conditions during the leaf formation period, the variation is such that in the more exposed habitat of the open meadow there is a marked difference in thickness of leaves of the north and south sides of the same tree, the leaves on the south side being thicker.

III.—Leaf Area Data

The area of fifty leaves from both woods and meadow was measured by means of a planimeter. The areas were plotted on graphs (Fig. 9), one for each set of fifty leaves. The graphs indicate that the range of leaf area for leaves from the woods is a little greater than of leaves in the meadow, and that the greater number of leaves from the woods are larger. These data substantiate the impression that one gets on observation of the two groups of trees, that of smaller leaves on trees in the open.

IV.—Gross Anatomy of Stems

Twenty-five stems from the north and south sides of trees in the open and the same number from trees in the woods were measured to determine the amount of annual increment in length of twigs and diameter of stems. In every case the annual increment in length of twigs from the woods was more than for the corresponding internodes of twigs from the open, while the twigs from the open were shorter and thicker. There was no consistent difference between the twigs from the north and south sides of trees in the open. The difference in internodal length of twigs from the woods and the open might be due to either of two things: greater numbers of cells or greater individual cell length. Actual measurements show a difference of 8% in the length of cells in the two groups so that this feature accounts largely for the greater internodal length of the twigs from the woods.

The feature of the great profusion of branching in the twigs in the open is a constant character and one of the most striking of the gross characters to the casual observer. Fig. 10 demonstrates the extent of the difference of profusion of branching and of internodal length between the two groups of twigs. Related to the greater number of twigs on trees in the open is the greater number of flowering buds on these same trees. There is also a difference in the number of flowering buds from the north to the south sides of

the trees in the open. Counts were made of all the flowering buds on the twigs of sixteen-year-old branches from ten trees in the woods and from the north and south sides of ten trees in the open. The results of these counts based on the averages follow:

Av. no. flower buds on 16 yr. branch of trees in woods	18
Av. no. flower buds on 16 yr. branch north side—open	35
Av. no. flower buds on 16 yr. branch south side—open	98

The appearance of the two groups of trees in the flowering season substantiates the data presented above. The trees in the open in the latter part of May, when they are in full bloom, is a sight of exquisite beauty and a notable contrast to the more sparsely flowered trees in the woods.

Summary

1. *Cornus florida* in an open meadow in Brown County, Ohio, has a rounder, fuller crown due to profuse branching and shortened internodes, than the same species in its ordinary habitat, the understory of the mixed mesophytic forest.

2. The foliar anatomy of the trees in the open carries on the difference in that the leaves are thicker and somewhat smaller than those from the woods.

3. Leaves from 1934 show, in addition to the difference between the leaves from the open and those from the woods, a difference between those from the north and south sides of the trees in the open.

4. The formative period for leaves in 1934 was drier, hotter, had a lower average relative humidity and a greater percentage of possible sunlight than the same period in 1935.

5. The climatological factors mentioned above account for the difference in leaves from one year to the next in that the drier, hotter season is interpreted as making possible greater variation from one side of the tree to the other.

6. The annual increment of twigs from the woods is more in length and less in diameter than for trees in the open. The difference seems to be largely a matter of cell length.

7. The habitat differences from the woods to the open are sufficient to produce the differences noted in leaves and twigs, and although variation does occur in the size and thickness of the leaves on trees in the open, this variation is more marked in drier seasons so that a differentiation between leaves from the north and south sides is distinct.

University of Cincinnati,
Cincinnati, Ohio.

Studies of Mexican and Central American Plants—V[1]

C. L. Lundell

The rich collections of Mr. Eizi Matuda in southern Mexico are yielding a surprising number of new and interesting species. His regular series now totals 1869 numbers and a special S-series extends through number S-224. The first set of the collection is in the Herbarium of the University of Michigan. Numerous additions to the flora of Mexico, particularly from the State of Chiapas, are represented. Seven new species from Matuda's collection are described in this paper.

Moraceae

Trophis cuspidata sp. nov.

Arbor. Folia subchartacea, subintegra, 10-14 mm. longe petiolata, oblongo-elliptica, 8.5-18.5 cm. longa, 3.3-7 cm. lata, apice cuspidata, basi acutiuscula, supra glabra, subtus breviter pilosa.

A tree; branchlets densely gray-pubescent, glabrescent very early. Leaves subchartaceous; stipules narrowly triangular, acuminate, 3 to 4 mm. long, deciduous very early; petioles 10 to 14 mm. long, pubescent; blades oblong-elliptic, 8.5 to 18.5 cm. long, 3.3 to 7 cm. wide, apex abruptly long-cuspidate, the cusp as much as 2.5 cm. long, base acutish, glabrous above, persistently short-pilose beneath, costa and lateral veins prominent beneath, reticulate, tawny, the main veins 6 to 8 on each side, margin subentire. Staminate inflorescences solitary, axillary, densely gray-pubescent, immature spikes 2.3 to 4.5 cm. long.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1051*, collected on Mt. Ovando,[2] near Escuintla, Chiapas, Mexico, December 23, 1936.

T. cuspidata may be readily distinguished from the other species in the genus by the persistently short-pilose undersurface of its leaves.

Lauraceae

In January 1936 Kostermans, after discussing the status of the genus *Acrodiclidium*, made the following recommendation[3]:

As the genus name *Licaria* has not been used for 150 years and the renaming of

1 Contribution from the Herbarium of the University of Michigan. Previous papers in this series have appeared as follows: I, Carnegie Inst. Washington Publ. **478**:208-221. 1937; II, Phytologia **1**:212-222. 1937; III, ibid. **1**:241-247. 1937; and IV, Field and Laboratory **6**:9-16. 1937.

2 Mt. Ovando is the correct spelling, not Mt. Orando.

3 Meded. Bot. Mus. Utrecht **25**:37. 1936.

about 30 species of *Acrodiclidium* would cause much confusion, I propose that the name *Licaria* Aublet, as this genus is moreover based on sterile material only, should be rejected and the name *Acrodiclidium* Nees should be retained.

In December of the same year, Kostermans published a revision of the genus *Acrodiclidium*,[4] rejecting *Licaria*. In November 1937, the same author, reversing his previous stand regarding *Licaria*, groups *Acrodiclidium*, *Misanteca* Cham. & Schl., and *Chanekia* Lundell together under that genus.[5]

Since *Licaria* is based upon sterile material of doubtful position, it seems more logical to use the name *Acrodiclidium*. This necessitates the following new combinations for the Mexican and Central American species.

Acrodiclidium Cervantesii (H.B.K.) comb. nov.
Laurus Cervantesii H. B. K., Nov. Gen. **2**:134. 1817.

Acrodiclidium Cufodontisii (Kosterm.) comb. nov.
Licaria Cufodontisii Kosterm., Rec. Trav. Bot. Néerl. **34**:591. 1937.

Acrodiclidium capitatum (Cham. & Schl.) comb. nov.
Misanteca capitata Cham. & Schl., Linnaea **6**:367. 1831.

Acrodiclidium excelsum (Kosterm.) comb. nov.
Licaria excelsa Kosterm., Trav. Bot. Néerl. **34**:595. 1937.

Acrodiclidium caudatum (Lundell) comb. nov.
Chanekia caudata Lundell, Phytologia **1**:178. 1937.

Acrodiclidium Peckii (Johnston) comb. nov.
Misanteca Peckii I. M. Johnston, Contr. Gray Herb. n.s. **70**:70. 1924.

Acrodiclidium campechianum (Standl.) comb. nov.
Ocotea campechiana Standl., Carnegie Inst. Wash. Publ. **461**:56. 1935.

LEGUMINOSAE

Indigofera Matudai sp. nov.

Frutex. Folia 12-15 cm. longa, petiolis 1.7-2 cm. longis. Foliola 17-23, lanceolato-oblonga, 2-3.6 cm. longa, 7-11 mm. lata, mucronata, basi acutiuscula vel rotundata, supra glabra, subtus ferrugineo-strigosa. Pedicelli 1.8-3 mm. longi. Calyx ca. 2 mm. longus. Corolla 7 mm. longa.

A shrub; branches sparingly ferruginous-strigose. Leaves 12 to 15 cm. long; stipules setaceous, 7 to 10 mm. long; petiole 1.7 to 2 cm. long, the petiole and rachis canaliculate, sparingly strigose; leaflets 17 to 23, usually 21, stipels setaceous, petiolules 1.5 to 3 mm. long, blades of leaflets lanceolate-oblong, 2 to 3.6 cm. long, 7 to 11 mm. wide, mucronate, base acutish to rounded, glabrous above, ferruginous-strigose beneath. Racemes many-flowered, equaling the leaves or shorter; bracts setaceous, caducous, 3 to 4 mm. long. Pedicels 1.8 to 3 mm. long, ferruginous-strigose. Calyx ferruginous-strigose, about 2 mm. long, the teeth acuminate, equaling or slightly longer than tube. Corolla 7 mm. long; banner oval, sessile, ferruginous-strigose on the back.

4 Rec. Trav. Bot. Néerl. **33**:719-754. 1936.
5 Rec. Trav. Bot. Néerl. **34**:575-604. 1937.

Pods (immature) reflexed, straight, linear, slightly flattened, 3.5 to 4 cm. long, sparingly ferruginous-strigose, 5- to 7-seeded.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1758*, collected on Finca Juarez, Escuintla, Chiapas, Mexico, Aug. 12, 1937.

I. Matudai, referable to the Thibaudianae (Rydberg, N. Amer. Fl. 24: 146. 1923), is closely related to *I. costaricensis* Benth. It is clearly distinct from that species in having longer stipules, 17 to 23 leaflets, a larger corolla, and longer legumes with fewer seeds. *I. costaricensis* has only 9 to 15 leaflets.

Pithecolobium Matudai sp. nov.

Frutex. Folia 9-15 cm. longa; pinnis 4-8-jugis; foliolis 16-26-jugis, lanceolatis vel oblongis, 7-10 mm. longis, 1.8-3 mm. latis, apice acuminatis. Inflorescentiae axillares, capitatae; pedunculis 1-3, gracilibus, 3-4 cm. longis. Calycis tubus 2 mm. longus, 5-dentatus. Corollae tubus ca. 4.5 mm. longus; lobi 5, ca. 1.3 mm. longi, adpresse rufo-puberuli. Staminum tubus 3 mm. longus. Ovarium glabrum. Legumina 7.5-8.5 cm. longa, moniliformia, coriacea, rufo-tomentulosa.

A shrub; twigs, petioles, leaf-rachis, and peduncles reddish-brown, scurfy-pubescent. Leaves 9 to 15 cm. long; the rachis bearing a sessile cupulate gland between each pair of pinnae; pinnae 4 to 8 pairs, the racheae of pinnae glabrous above, hirsute beneath; leaflets 16 to 26 pairs, lanceolate to oblong, 7 to 10 mm. long, 1.8 to 3 mm. wide, apex obliquely acuminate, entirely glabrous except for a few hairs along the costa above and along the margin, costa prominent beneath, the veins nearly obsolete, reticulate. Inflorescence capitate on axillary peduncles; peduncles 1 to 3, slender, 3 to 4 cm. long. Flowers numerous, subtended by spatulate bracts, the bracts 1 mm. long, pubescent with red hairs. Calyx tube 3 mm. long, glabrous, 5-dentate, the teeth about 0.5 mm. long, pubescent with short red appressed hairs. Corolla tube about 4.5 mm. long, glabrous or nearly so, 5-lobed, the lobes about 1.3 mm. long, pubescent with short red appressed hairs. Stamens 8 or 9 mm. long, glabrous, the filaments united into a short included tube 3 mm. long. Ovary sessile, glabrous. Legume moniliform, 7.5 to 8.5 cm. long, red, coriaceous, rufous-tomentulose, especially along the sutures.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1835*, collected on Mt. Ovando, near Escuintla, Chiapas, Mexico, April 9-12, 1937.

P. Matudai, which is closely related to *Cojoba guatemalensis* Britt. & Rose (N. Amer. Fl. 23: 30. 1928), differs from that species, according to the description, in having 16 to 26 pairs of leaflets instead of 8 to 17 pairs, these being acuminate rather than obtuse.

RUTACEAE

Zanthoxylum atoyacanum sp. nov.

Frutex. Folia 10-22 mm. longe petiolata, rachi alata; foliola 6-9, elliptica, 1-3.5 cm. longa, 0.6-1.3 cm. lata, apice obtusa, basi cuneata, utrinque lepidota,

crenata. Inflorescentiae axillares, racemosae, 1-3.5 cm. longae. Pedicelli florium masculorum 1-2 mm. longi. Sepala 4, raro 5, late ovata vel suborbicularia, ca. 1 mm. longa. Petala 4, raro 5, oblongo-elliptica, ca. 3 mm. longa, 1.5-1.7 mm. lata, glabra. Stamina 4, raro 5. Filamenta glabra, ca. 4 mm. longa.

A shrub; twigs slender, zigzag, short hirsute and brown lepidote, armed with nearly straight stipular spines 3 to 8 mm. long. Leaves 5 to 10 cm. long, mostly clustered on short spurs, odd-pinnate or even-pinnate by reduction of terminal leaflet, the petiole and rachis winged, 2 to 5 mm. wide; petiole 10 to 22 mm. long; leaflets 6 to 9, elliptic, 1 to 3.5 cm. long, 0.6 to 1.3 cm. wide, apex obtuse, base cuneate, shallowly crenate with pellucid glands below the crenatures, sessile or subsessile, opposite, base subequal, with small inconspicuous thickening on each side, lustrous above with a few hairs along the costa, persistently but sparingly pubescent beneath, lepidote on both surfaces. Inflorescence axillary, mainly crowded on the short leafy spurs, racemes spike-like, 1 to 3.5 cm. long, scurfy and short hairy; bracts ovate-elliptic, about 1 mm. long, rounded at apex, thick. Staminate flowers: pedicels scurfy, 1 to 2 mm. long. Sepals 4, rarely 5, broadly ovate or suborbicular, about 1 mm. long, glabrous except for a few brown scales, margin minutely erose. Petals 4, rarely 5, oblong-elliptic, about 3 mm. long including a short claw, 1.5 to 1.7 mm. wide, glabrous. Stamens 4, rarely 5; filaments glabrous, about 4 mm. long. Rudimentary ovary, gynophore, and the 2 styles glabrous, about 2.1 mm. long. Pistillate flowers and fruits unknown.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1489*, collected at Atoyac, Vera Cruz, Mexico, May 14, 1937.

Z. atoyacanum is noteworthy for the comparatively broad winged petiole and leaf rachis, short spike-like racemes borne mainly on the leafy spurs, scurfiness of all parts excepting the petals and stamens, and the persistent, although sparse, hairs. It is closely related to *Z. Culantrillo* H.B.K., but differs in its broader winged leaf-rachis, elliptic and obtuse leaflets, shorter racemes, and scurfiness.

Myrtaceae

Eugenia siltepecana sp. nov.

Arbor; ramulis dense pubescentibus. Folia subchartacea, 5-8 mm. longe petiolata, lanceolato-elliptica vel oblongo-elliptica, 8-14.5 cm. longa, 3.5-7 cm. lata, apice attenuata, obtusa, basi acuta, subtus pilosa, fulva. Infructescentia axillaris, breviter racemosa. Pedicelli fructiferi 2.5-5 mm. longi, hirsuti. Bacca globosa, ca. 1.7 cm. diam., punctata, breviter hirsuta.

A tree; branchlets rufous, densely pubescent. Leaves subchartaceous, large; petioles stout, densely pubescent, 5 to 8 mm. long; blades lanceolate-elliptic or oblong-elliptic, 8 to 14.5 cm. long, 3.5 to 7 cm. wide, apex attenuate, obtuse, base acute, slightly decurrent, glabrescent above except along the costa, persistently pilose beneath, densely so along the very prominent costa, paler and fulvous beneath, the main veins 12 to 16 on each side. Infructescence

axillary on older branchlets, short-racemose, the rachis scarcely discernible, few-flowered; fruiting pedicels 2.5 to 5 mm. long, hirsute; fruits 1-seeded, globose, about 1.7 cm. in diameter, prominently punctate, persistently short-hirsute; the persistent calyx 4-lobed, the lobes broadly ovate, 3 to 3.5 mm. long, 2.7 to 3 mm. wide, hirsute outside, puberulent within.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1594*, collected at Siltepec, District of Mariscal, Chiapas, Mexico, August 9, 1937.

E. siltepecana is noteworthy for its large pubescent leaves and fruits.

ONAGRACEAE

Hauya Matudai sp. nov.

Arbor; ramulis pubescentibus. Folia parva, coriacea, 1-2.7 cm. longe petiolata, obovato-elliptica, 4-8 cm. longa, 2.5-5.2 cm. lata, apice abrupte acuminata, basi rotundata vel subcordata, supra rugosa, adulta subglabra, subtus dense pilosa, supra immerse subtus prominenter costata. Flores axillares solitarii, 4-7.5 mm. longe pedunculati. Calyx tubus 5-5.7 cm. longus, lobis 4-4.7 cm. longis, apice appendiculatis. Petala late ovata, 3.2-4 cm. longa, ca. 2.2 cm. lata. Capsula 4.8-5.5 cm. longa.

A tree; branchlets pubescent. Leaves small, coriaceous; stipules subulate, about 2.5 mm. long; petioles slender, 1 to 2.7 cm. long; blades obovate-elliptic, 4 to 8 cm. long, 2.5 to 5.2 cm. wide, apex abruptly acuminate, base slightly unequal, rounded or subcordate, margin rather sinuate, rugose and glabrescent above, persistently pilose beneath, costa and veins impressed above, prominent beneath, the main veins 8 or 9 on each side. Flowers solitary, axillary, pedunculate, the peduncles 4 to 7.5 mm. long. Calyx tube to 5.7 cm. long, the lobes 4 to 4.7 cm. long, 5 to 9 mm. wide at base, appendaged, the appendages 3 to 5 mm. long, tube and lobes sparingly pubescent with short somewhat appressed hairs. Petals broadly ovate, 3.2 to 4 cm. long, about 2.2 cm. wide, glabrous, apparently rounded at apex. Filaments about 2 cm. long, glabrous. Ovary about 13 mm. long, pubescent with short somewhat appressed grayish hairs. Capsule 4.8 to 5.5 cm. long. Seeds numerous, 8 to 10 mm. long.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1734*, collected at Cascada, Siltepec, District of Mariscal, Chiapas, Mexico, August 5, 1937.

H. Matudai is distinguished by its small rugose, subcordate, densely pilose leaves, medium-sized pedunculate flowers with appendaged calyx lobes, and large capsules. Its closest relative appears to be *H. Rusbyi* D. Sm. & Rose, which differs in its larger oblong-ovate leaves, much shorter calyx tube, and smaller capsules.

MYRSINACEAE

Parathesis Matudai sp. nov.

Frutex. Ramuli novelli adpresse ferrugineo-tomentelli. Folia chartacea, 6-10 mm. longe petiolata, anguste obovato-elliptica, 10.5-18.5 cm. longa, 4.5-

7 cm. lata, apice acuminata, basi acutiuscula, nigripunctata, supra immerse subtus prominenter costata. Inflorescentia axillaris, 5.5-8 cm. longa, bipinnata, pauciflora; pedicellis 6-7 mm. longis, puberulis. Flores ante anthesin 3.5-4 mm. longi. Petala basi breviter connata, lanceolata, 4-5 mm. longa, acuta, punctata, extus puberula, intus breviter tomentosa. Ovarium cum styli basi pilosum.

A shrub; branchlets appressed ferruginous-tomentulose at first. Leaves chartaceous, black-punctate, sparingly appressed ferruginous-tomentulose at first, especially along the costa and veins, glabrescent very early; petioles canaliculate, 6 to 10 mm. long; blades narrowly obovate-elliptic, 10.5 to 18.5 cm. long, 4.5 to 7 cm. wide, apex acuminate, base acutish, costa and veins impressed above, very prominent beneath, main lateral veins 14 to 18 on each side, margin subentire. Inflorescence axillary, 5.5 to 8 cm. long, bipinnate, narrow, few-flowered, the flowers in umbels of 3 to 6; peduncles appressed brown-tomentose; pedicels 6 to 7 mm. long, puberulent. Flower buds 3.5 to 4 mm. long. Sepals puberulent, connate at base, the lobes triangular, acute, about 0.6 mm. long. Petals connate at base, lanceolate, 4 to 5 mm. long, acutish, punctate, puberulent outside, densely short tomentulose inside. Filaments short, 1 mm. long or less, glabrous. Anthers lanceolate, 1.5 to 2 mm. long, acute or subacuminate, dorsally black punctate. Ovary and base of style pilose, the style about 3 mm. long, minutely punctate.

Type in the Herbarium of the University of Michigan, *Eizi Matuda 1501*, collected on Cerro Punta Coscomat, Vera Cruz, Mexico, May 10, 1937.

P. Matudai is related to *P. Rekoi* Standl., *P. melanosticta* (Schlecht.) Hemsl., and *P. pleurobotryosa* D. Sm. *P. Rekoi* differs in having smaller leaves, many-flowered longer inflorescences, shorter anthers, and a glabrous ovary. *P. melanosticta* has narrower elliptic leaves not as prominently veined as *P. Matudai*, a much larger inflorescence, and larger flower buds. In *P. pleurobotryosa* the leaves are elliptic-lanceolate, smaller, and the flower buds are 5 mm. long.

University of Michigan,
Ann Arbor, Michigan.

A New Phlox from the Snake River Canyon Idaho-Oregon

Edgar T. Wherry and Lincoln Constance

In the course of the study of the genus *Phlox* being carried on by the senior author, the existence of a hitherto undescribed member of the genus in the Snake River region was recognized. Specimens were found to be preserved in several herbaria, variously identified as *P. linearifolia, P. longifolia,* or *P. whitedii,* although it differs markedly from these. Its nearest relative is *P. speciosa* var. *nitida* Suksdorf, with which it agrees in glabrous herbage and short styles, but on the average its leaves are narrower, flowers fewer, pedicels longer, calyx-membranes more carinate, and corolla-lobes longer. Moreover, while in all normal *P. speciosa* the corolla-lobes are notched, becoming entire only in rare mutants, in the present plant these lobes are consistently notchless and terminally obtusish, acutish or mucronate. In addition, it occupies a range remote from that of the Pacific-border var. *nitida,* so may well be classed as an independent species. A name for it has been derived from one of the Latin terms for snake, in reference to its region of occurrence.

Phlox colubrina sp. nov.

Plant a slender glabrous shrub 15 to 50, averaging 30 cm. tall; leaves thinnish or with somewhat thickened margins, narrowly linear; the largest 40 to 80, average 50 mm. long, and 1 to 2 (rarely 2.5), average 1.5 mm. wide; inflorescence 1 to 6 or rarely 12-flowered; pedicels 18 to 70, average 35 mm. long; sepals 8 to 12, average 10 mm. long, united ½ to ⅔ their length; membranes of calyx-tube rather distinctly carinate, the lobes glabrous externally but pilose on their inner surface; corolla-tube 9 to 15, averaging 11 mm. long, sometimes constricted near its orifice, externally glabrous; lobes 9 to 20 by 4 to 7 mm., usually 2 to 3 times as long as wide, terminally varying from obtusish to acutish or to mucronate; stamens deep within the tube, rarely less than 3 mm. below the orifice; styles 1.5 to 4, averaging 2.5 mm. long, free and stigmatic for $^1/_3$ to $^2/_3$ their length.

Frutex parvus, glaber; folia circa 1.5 mm. lata; corollae lobi latitudine 2-3-plo longiores obtusiusculi, acutiusculi vel mucronati; styli 1.5-4 mm. longi.

Type in Herbarium Academy of Natural Sciences of Philadelphia, collected by Lincoln Constance, H. Heggeness, D. Hedrick, and D. Peters, No. 1823, May 13, 1937, 1 mile above the mouth of Sheep Creek, a tributary of the Snake River, Idaho County, Idaho, latitude 45° 27½′ N., longitude 116° 32½′ W.

Other collections known to date are listed herewith, the herbaria being abbreviated to groups of letters which obviously represent them:

IDAHO. Idaho Co.: Snake River Canyon 2 m. n. of Sheep Cr., 45°29′, 116°33½′, Constance, Rollins & Dillon 1595, 5/16/'36 (Wash. St. and ANSP); mouth of Willow Creek, 45°29½′, 116°33½′, Constance, Hedrick & Peters 1821, 5/13/'37.

OREGON. Wallowa Co.: near mouth of Battle Creek, 45°18½′, 116°40½′, Peck 18143, 3/27/'34, (Will. U. & ANSP); 4 m. ne. of Buckhorn Spr., 45°48′, 116°47′, Peck 18286, 6/27/'34 (Will. U. & ANSP); headw. left fk. Cache Cr., 45°59′, 116°58′, Sheldon 8185, 5/28/'97 (NYBG, USNH); Cache Cr. Bar, alt. 800′, 45°59′, 116° 54½′, Constance, Rollins & Dillon 1548, 5/14/'36 (Wash. St. & ANSP); Cherry Cr. at 2000′, 45°50′, 116°50′, Jardine 388, 4/5/'09 (U. S. For. Serv.); Snake Canyon near Deep Cr., 1000′, 45°47′, 116°40′, C., R., & D. 1567, 5/15/'36 (Wash. St. & ANSP); Imnaha, 45°33½′, 116°50′, Sherwood 73, 6/4/'23 (Will. U. & Field M.); m. Imnaha R., 45°49′, 116°46′, G. N. Jones 6440, 4/11/'31 (U. Wash. & ANSP); n. slope Mt. Wilson, 45°49′, 117°5′, Sheldon 8094, 5/20/'97 (NYBG, USNH).

Fig. 1. *Phlox colubrina* in the Snake River Canyon.

Fig. 2. The type specimen of *Phlox colubrina*.

This is the common *Phlox* of the Snake River Canyon and its tributary streams from about the mouth of the Grand Ronde River to the north edge of Hell's Canyon, where the river cuts its channel between the Wallowa and Seven Devils ranges. Doubtless the species extends still farther south but the canyon has not been explored above this point. Within this deep trough, *Phlox colubrina* ranges through a variety of habitats, appearing to be equally at home in the timbered and timberless Arid Transition and the badly overgrazed Upper Sonoran Zone. A list of its associates would comprise a considerable proportion of the highly endemic canyon flora. In the timber belt it is found under *Pinus ponderosa* and *Amelanchier Cusickii* in company with

Castilleja angustifolia, Brodiaea Douglasii and *Arabis crucisetosa,* and spreads down through the bunchgrass climax with these and other herbs. Perhaps its frequency is highest on the dry basaltic ledges of the Upper Sonoran whose sparse vegetation is dominated by *Celtis Douglasii, Amelanchier Cusickii, Rhus glabra, R. Toxicodendron, Ribes Gooddingii* and *Opuntia polyacantha.* In the most severely grazed sectors, the *Phlox* often persists solely within the protective presence of *Opuntia* (see Fig. 1) and *Rhus glabra,* surrounded by such unpalatable herbs as *Amsinckia, Leptotaenia, Cogswellia fragrans, Erigeron concinnoides* and *Lupinus sericeus.* Plants of the last habitat, growing in crannies in the volcanic rock, are usually more obviously shrubby and more numerous flowered than the lax and sprawling, few-flowered individuals found in the partial shade of shrubs. The soil reaction is practically neutral (pH 6.8 to 7.2).

Corolla color is somewhat variable, but most of the fresh material showed the outside of the lobes and tube to be (terminology according to Ridgway) "Pale Laelia Pink," and the inside to range from "Light Rosolane Purple" to "Rosolane Purple." The lobes are frequently bimaculate at the throat with deeper hues of the same color, and a few plants were found with pure white corollas. The flowers of *Phlox longifolia* Nutt., a species which replaces *P. colubrina* in the Snake River Canyon in the vicinity of the mouth of the Clearwater River, have the lobes "Pale Rose-Purple" outside and "Light Mallow Purple" within.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, PA.
AND
UNIVERSITY OF CALIFORNIA.
BERKELEY, CALIFORNIA.

Bryophyta of Arctic America. I. Species from Little Diomede Island, Bering Strait, Alaska*

William Campbell Steere

Several collections of bryophytes from various parts of Arctic and sub-Arctic North America, some of them of very considerable size, have come in from different sources for identification. In this series of papers each collection will be reported upon as a unit.

The boreal bryophyte flora is of extreme interest for several reasons. In the first place, north of latitude 60° N., it is known only very imperfectly from few and scattered collections, so that nearly all collections result in great extensions of known geographic ranges. In the second place, it is important to gather data and information which may eventually enable us to establish whether or not there are endemic Arctic bryophytes, or whether there is a whole floristic element which has originated in Arctic America.

The first collection to be reported upon consists of twenty-two packets collected August 14-20, 1926, on Little Diomede Island, in Bering Strait (latitude 65° 46′ N., longitude 168° 55′ W.), by A. E. and R. T. Porsild. Dr. A. E. Porsild, of the National Herbarium of Canada, Botanist to the Canadian Government, had the kindness to send me this small but interesting collection for identification, and has also given me permission to report on it.

The collection is important in that it comes from a locality in the supposed migration route between Asia and America. Big and Iittle Diomede Islands are almost exactly midway between East Cape on the Siberian coast and Cape Prince of Wales on the Alaskan side of Bering Strait; in fact, the International Boundary runs between the two islands. Bering Strait is less than fifty miles wide at this point of closest approximation of the Asiatic and American continents. Since it is generally agreed that the migration of Asiatic plants to the American mainland, and vice versa, occurred across Bering Strait, the bryophyte flora of the islands lying along this route between the two continents should be of exceptional interest to phytogeographers.

Curiously enough, insofar as I have been able to discover, there are no published reports of any kind concerning the flora of the Diomede Islands. In fact, there are very few reports of Bryophyta from the Bering Strait region, as a whole. Holzinger and Frye (1921) refer to a few collections of mosses made at Cape Prince of Wales, and Arnell (1917) has made an interesting report on the bryophytes collected by F. R. Kjellman, botanist to the Vega Expedition (1878-1880), on St. Lawrence Island, some two hundred miles south of Bering Strait.

* Papers from the Department of Botany and the Herbarium of the University of Michigan, No. 646.

Hepaticae

PTILIDIACEAE

1. *Blepharostoma trichophyllum* (L.) Dum. A few stems of this inconspicuous species were found intermixed with *Polytrichum alpinum* Hedw. and *Drepanocladus revolvens* (Sw.) Warnst.

2. *Ptilidium ciliare* (L.) Hampe. One whole collection consisted almost entirely of this species, whereas in another collection it accompanied *Dicranum Bonjeani* DeNot.

3. *Chandonanthus setiformis* (Ehrh.) Lindb. (*Temnoma setiforme* [Ehrh.] Howe). One collection was composed almost wholly of this uncommon species. In another collection a few strands were found associated with *Hylocomium splendens* (Hedw.) Bry. eur. This species is apparently not yet known from continental Alaska, but has been reported from St. Matthews Island (Evans, 1900) and St. Lawrence Island (Arnell, 1917).

Musci

ANDREAEACEAE

4. *Andreaea rupestris* Hedw. Only a few plants of this species, bearing sporophytes, were found at the edge of an otherwise pure growth of the preceding species. The genus *Andreaea* is not at all common or well represented by different species in Alaska, even by this commonest one.

SPHAGNACEAE

5. *Sphagnum Girgensohnii* Russ. One collection consisted almost entirely of this moss.

DITRICHACEAE

6. *Ceratodon purpureus* (Hedw.) Brid. Two collections were of this species in pure growth, with sporophytes. Occasional plants were seen in other collections, also.

DICRANACEAE

7. *Oncophorus Wahlenbergii* Brid. A few stems of this unmistakable moss were found associated with *Polytrichum alpinum* Hedw. and *Drepanocladus revolvens* (Sw.) Warnst.

8. *Dicranum Muhlenbeckii* Bry. eur. One collection consisted of several pure tufts of this moss.

9. *Dicranum fuscescens* Turn. A few specimens of this species were found intermixed with *Sphagnum Girgensohnii* Russ.

10. *Dicranum scoparium* Hedw. This common moss was found only in mixture, with *Ptilidium ciliare* (L.) Hampe in one collection and with *Hylocomium splendens* (Hedw.) Bry. eur. in another.

11. *Dicranum Bonjeani* DeNot. One collection consisted of an almost pure tuft of this species, slightly mixed with *Ptilidium ciliare* (L.) Hampe.

GRIMMIACEAE

12. *Rhacomitrium lanuginosum* (Hedw.) Brid. Two collections consisted entirely of this.

BRYACEAE

13. *Pohlia nutans* (Hedw.) Lindb. A few plants of this species were found intermixed with *Ceratodon purpureus* (Hedw.) Brid.

14. *Pohlia cruda* (Hedw.) Lindb. There are two collections of this common boreal species.

MNIACEAE

15. *Mnium cinclidioides* (Blytt) Hüben. This handsome species, which is not at all common in Alaska, was found in only one collection, mixed in almost equal parts with *Calliergon stramineum* (Brid.) Kindb.

ENTODONTACEAE

16. *Pleurozium Schreberi* (Willd.) Mitt. (*Calliergonella Schreberi* Grout). The single large collection of this moss, which is unmixed with other species, represents a very odd form. Although the stems are almost normally branched, i.e. in a regular pinnate manner, and the stems are characteristically red, the stem leaves are broadly truncate or sometimes even retuse at the apex. The alar cells of all leaves are orange and vey distinctive. All basal cells, including the alar, are strongly pitted. The apical cells of the stem leaves are much shorter than the others and are furnished with heavy collenchymatous thickenings. The species in Alaska, as elsewhere, is very variable. One of the more distinctive Alaskan variants has been named *Hypnum* (*Calliergon*) *tananae* Grout (Holzinger and Frye, 1921), but is now considered only a variety of *P. Schreberi.* In view of the many simple synonyms of P. *Schreberi,* which indicate its polymorphism, it is considered inadvisable to propose even varietal status for this plant until other collections verify its distinctness.

AMBLYSTEGIACEAE

17. *Drepanocladus revolvens* (Sw.) Warnst. In one collection this characteristic species is about equally mixed with *Polytrichium alpinum* Hedw.

18. *Drepanocladus uncinatus* (Hedw.) Warnst. This species is represented by two large, unmixed collections, and by occasional stems straggling through other collections. It is a very common boreal and Arctic moss, and from these collections may be considered as one of the characteristic species of Little Diomede Island.

19. *Calliergon sarmentosum* (Wahlenb.) Kindb. This species composes one whole collection and is represented by scattered stems in two collections,

being mixed with *Dicranum Bonjeani* DeNot. and in the other with *Polytrichum alpinum* Hedw. and *Drepanocladus revolvens* (Sw.) Warnst.

20. *Calliergon stramineum* (Brid.) Kindb. This species was found only in mixture. In one collection, as previously noted, it was mixed about equally with *Mnium cinclidioides* (Blytt) Hüben. and in the other a few strands were mixed with *Polytrichum alpinum* Hedw.

HYLOCOMIACEAE

21. *Hylocomium splendens* (Hedw.) Bry. eur. The one unmixed collection of this species is a form close to *H. alaskanum* (Lesq. & James) Kindb., which is only a reduced, Arctic phase.

POLYTRICHACEAE

22. *Psilopilum cavifolium* (Wils.) Hagen. One collection is composed wholly of this interesting species, in good fruiting condition. It is not common in Alaska, being known there from very few collections.

23. *Polytrichum alpinum* Hedw. There are two relatively unmixed collections of this species, one of them with abundant fruit. There are also two good collections of *P. alpinum* Hedw. var. *brevifolium* C. Müll., a well marked variety, both with mature sporophytes.

24. *Polytrichum juniperinum* Hedw. A few sterile stems of this moss were found mixed with *Ptilidium ciliare* (L.) Hampe.

25. *Polytrichum strictum* Brid. One large sterile collection consists entirely of this species, which is easily identified, even when sterile.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICHIGAN.

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Studies on Larval Trematodes from Kentucky with a Summary of Known Related Species

Raymond M. Cable

Although larval trematodes have received much attention in adjacent states, abstracts of the present study (Cable, 1935a, b) constitute the only record in the literature of cercariae from Kentucky. The present report is limited to the trematode parasites of a single snail species, *Goniobasis semicarinata* (Say), collected over a period of three years in the vicinity of Berea, Kentucky. These collections have yielded four new species of cercariae of types not commonly reported from freshwater habitats in the United States. For this reason, it seems desirable to describe these forms as completely as possible.

The snails were collected from Scaffold Cane and Cowbell creeks in Madison County. *G. semicarinata* is a very hardy snail, being able to withstand severe drouths during which all water in these streams dries up except a few scattered pools which become very stagnant. The snails are migratory in habit, moving in the early summer from deeper water up spring-fed tributaries, and may be found in the smallest rivulets in the upper wooded ravines. The colder water of these tributaries is favorable apparently for breeding since snails collected there often lay eggs when taken into the laboratory. The eggs are small and deposited singly, making it difficult to find them under outdoor conditions. Attempts at rearing *G. semicarinata* have been unsuccessful although adults may be kept alive in the laboratory for several months.

The snails were isolated in finger bowls and examined for emerging cercariae which were removed and studied, both alive and after fixation and staining with paracarmine. Intra-vitam staining with neutral red, Bismarck brown and methylene blue were also employed. All drawings are made to scale from measurements of living specimens under just sufficient coverglass pressure to prevent active swimming. The writer is obliged to Dr. Calvin Goodrich of the University of Michigan for the identification of molluscan material.

Cercaria kentuckiensis Cable, 1935a

(Figs. 6, 8)

Host: *Goniobasis semicarinata* (Say)

Locality: Scaffold Cane Creek, Madison Co., Ky.

Specific diagnosis: Longifurcocercous, pharyngeate distome; body pyriform, ventral surface concave; body measures 0.275 mm. long by 0.14 mm. wide. Tail attached dorsally; tail-stem 0.39 mm. long and 0.045 mm. wide; furcae 0.335 mm. long and provided with fin-fold on dorsal and ventral edges, continuous around tip. Body and furcae spinose; tail-stem without spines but with long hair-like processes; shorter hair-like structures on body. Ventral sucker rudimentary; oral sucker a protrusible penetration organ, 0.06 mm. long by 0.048 mm. wide; gland cells in oral sucker and

anterior region of body. Prepharynx very short; pharynx 0.026 mm. long by 0.024 mm. wide; esophagus short, intestine prominent with tortuous ceca extending to the excretory vesicle. Four ascending excretory trunks; excretory pore dorsal, at base of tail; Island of Cort present; excretory formula 2[(14)+3]; capillaries of tail-stem join collecting tubules of body; caudal excretory tubule bifurcated posteriorly, with branches extending to tips of furcae. Genital primordium prominent, immediately anterior to the excretory vesicle and between the median ascending excretory trunks. Develop in long, slender daughter sporocysts parasitizing the digestive gland of the snail; mother sporocysts in the mantle region. Cercariae encyst in fins and integument of small fishes.

C. kentuckiensis is not markedly photopositive although it responds to shadows by swimming upward in a rapid, jerky manner, and then settling slowly to the bottom of the dish. While at rest, the tail is flexed (Fig. 6) usually to the right, sometimes to the left, so that the distal half of the tail-stem is bent at about 90 degrees to the body axis. Older cercariae may creep over the bottom of the dish with rapid inchworm movements of the body, the flexed tail occasionally lashing violently. Decaudation is frequently observed in living cercariae mounted for examination. Shortly after the tail is lost, it becomes vacuolated, contracts, and the furcae roll into a spiral. The larva will attempt to penetrate almost any material in its path, and frequently forces its way into vaseline used in sealing the coverglass. In such attempts at penetration, a granular substance is secreted from the glands of the penetration organ. The larvae live for 36 to 48 hours after emerging from the snail.

Neutral red has a selective action on the glands of the penetration organ and fore-body, the intestinal ceca, and the Island of Cort, while other structures including the nuclei of the body and tail and the genital primordium are less intensely stained.

The entire body is spinose with the exception of a large concavity on the posteroventral surface. Spination is heaviest at the anterior end of the body, and becomes gradually lighter over the dorsal side for about three-fourths the length of the body. The number and size of spines then increase toward the posterior end. Spination on the ventral side of the body also becomes lighter posteriorly, stopping abruptly at the anterior margin of the ventral concavity. The body is also provided with delicate hair-like processes about 0.005 mm. long, set in papillae of which about five may be observed along each side of the body posterior to the pharyngeal level.

The tail is attached dorsally about 0.03 mm. from the posterior end of the body. The tail-stem tapers toward the point of attachment. Its surface is finely crenated and the lateral edges are provided with delicate trichoid structures, about 0.018 mm. long and increasing in number toward the distal end of the tail-stem. The lateral muscle fields of the tail-stem are composed of fibers extending posteromesad, giving the tail-stem a "herringbone" appearance. The muscle fibers were observed to be distinctly striated when examined with the highest powers of the microscope. Numerous nuclei underlie the cuticula of the tail and several large cells with finely granular cytoplasm are distributed along the caudal excretory tubule. These cells do not have the appearance of the so-called caudal bodies described for other species of furco-

cercariae. The furcae are curved and very slightly constricted at the base. A slight prolongation of the tail-stem beyond their point of attachment forms a distinct tubercle which might be mistaken for the excretory pore. The furcae are covered wih minute spines and are provided with prominent fin-folds.

The digestive system is the most conspicuous internal structure of either living or stained specimens. The prominent ceca are thin-walled, irregular sacs, filled with small crescentic or concavo-convex bodies, the larger of which are about 0.003 mm. in diameter. These bodies adhere to the walls of the ceca as well as float freely in the cecal fluid.

The structure interpreted as the ventral sucker is a small mass of cells embedded in the ventral side of the body anterior to the genital primordium. It is quite possible that this mass may be the developing holdfast organ, but this interpretation is not supported by the structure of the metacercaria. The genital primordium is not differentiated into ovarian and testicular masses. It is best observed in permanent mounts.

The excretory system is characteristic of the Vivax group of furcocercariae. The thin-walled excretory vesicle receives four ascending trunks, one pair of which is median in position, the other lateral. The median trunks extend anteriorly around the genital primordium and ventral sucker, fusing just anterior to the latter to form a common median trunk. This trunk extends anteriorly almost to the esophagus where it divides, sending lateral branches across the intestinal ceca to join the lateral ascending trunks. On each side, just posterior to this junction, collecting tubules arise from the lateral trunk. The anterior end of each lateral ascending trunk divides at the esophageal level, sending one branch anteriorly, the other medially where it may or may not unite with the corresponding branch from the opposite side of the body. Both median and lateral ascending trunks and their branches described above are provided with small, refractile concretions. There are 14 pairs of flame cells in the body and three pairs in the tail-stem. The capillaries and their connections were observed only in the tail. The flame cells in the tail-stem are attached to the median caudal excretory trunk, the group on the right side being definitely anterior to those on the left. On each side, the capillaries of these flame cells unite and their collecting tubule extends anteriorly, parallel to the median excretory trunk of the tail. The caudal tubules pass from the base of the tail into the body where they were traced anteriorly as far as the genital primordium. It is certain that they do not join either the caudal trunk or the excretory bladder as described for other species *(vide infra)* and owing to the difficulty encountered in tracing them it is believed that they may be similar in all members of the group. The caudal excretory trunk is loosely suspended in the tail-stem and its position varies with the movements and contractions of the tail. The furcal tubules are difficult to observe since they are closely applied to the posterior edges of the furcae. However, they may become greatly enlarged for a few seconds after the tail becomes detached, and may be easily seen during this brief period before disintegration begins Excretory openings at the tips of the furcae were not observed and the absence of such pores is supported by the behavior of the furcal tubules after decauda

tion in which the base of the tail constricts, closing the proximal end of the caudal excretory tubule.

C. kentuckiensis encysts in several species of cyprinid fishes. The metacercariae are found between the fin rays and beneath the scales of the body where they usually are not deeply imbedded. While life history experiments have not been completed, it is certain that this species is a larval holostome since the metacercaria possesses unmistakable strigeid characters. This observation is in agreement with the studies of other investigators on life cycles involving similar cercariae. Szidat (1933) traced the life cycle of *Distomum viviparae* von Linstow, the cercaria of which is similar to *C. kentuckiensis*. He observed that this larva encysted in the molluscan host, and he recovered immature holostomes upon feeding the metacercariae to albino rats. For the species he erected the genus, *Linstowiella* with *L. viviparae* (von Linstow) as type. He also expressed the belief that *Cyathocotyle* and *Prohemistomum* have similar cercarial stages. Azim (1933) has traced the life history of *Cercaria vivax* Sonsino, which encysts in small fishes. Azim fed infected fishes to cats and dogs and recovered adult holostomes identified as *Prohemistomum vivax* (Sonsino). Egyptian kites serve as the natural host of this strigeid which Odhner (1913) originally described as *Prohemistomum spinulosum*.

Sewell (1922), in his monograph on Indian cercariae, divided the furcocercariae into three groups. Group 1 included the apharyngeate, brevifurcous cercariae. Group 2 included the pharyngeate, longifurcate cercariae with the exception of a single species, *C. indica XXII*, which he placed in the separate "Baiswan" subgroup, since it had certain characteristics in common with both longi- and brevifurcate groups. Miller (1926) has revised and extended Sewell's classification of these groups. The third group, of which *C. kentuckiensis* is the first representative to be described from the United States, included pharyngeate cercariae with moderately long furcae and acetabulum either rudimentary or lacking. A striking characteristic of this group is the excretory system, which has a general resemblance to that of *C. kentuckiensis*. Sewell subdivided his Group 3 into the "Vivax" and "Tetis" subgroups which he characterized as follows:

"Vivax" Subgroup

1. The acetabulum is extremely small and rudimentary.
2. The furcal rami are provided with fin-folds that extend the whole length of the margins, and are continuous around the distal end.
3. The excretory system is very highly developed, and there are twelve pairs of flame cells in the body and three pairs in the tail: so that the excretory formula is $2\times12(+3)\times1=24(+6)$ flame cells.

"Tetis" Subgroup

1. The acetabulum is completely absent.
2. The furcal rami are devoid of fin-folds along their margins.
3. The excretory system, while possessing the same type as in the "Vivax" subgroup, is of a more simple structure and possesses only five pairs of flame cells in the body and two pairs in the tail, and the collecting tube from these opens into the lateral main canal of the body and not, as is apparently the case in the "Vivax" group, into the caudal canal.

Sewell assigned *C. vivax* Sonsino, *C. indica XV* and *C. indica LVIII* to the "Vivax" subgroup while the "Tetis" subgroup was allotted a single species, *C. indica XXXIII*. Faust (1922) described *C. leptoderma* from China and later (1924) placed it in a separate subgroup, "Leptoderma," since it lacked an acetabulum and has an excretory formula of $2[(3+3+3)+(3+3+3)]$. Miller (1926) included Faust's species in the "Vivax" group, thereby following Sewell's original classification. Tubangui (1928) described *C. dorsocauda* from the Philippines. In this species as in *C. vivax*, there are 12 pairs of flame cells in the body and three pairs in the tail-stem. However, according to Tubangui, the caudal collecting tubules join the posterior region of the bladder and excretory openings are present at the tips of the furcae. McCoy (1928) described *Cercaria R* from Tortugas, Florida, assigning it to the "Vivax" subgroup. Another species, *C. tauiana* Faust, differs from all previously known members of the group in that it has six pairs of flame cells in the body and none in the tail. For this species, Szidat (1933) proposed a distinct "Tauiana" subgroup and accepted Faust's (1924) "Leptoderma" subgroup. In addition, he described three new species, *C. curonensis, C. balthica* and *C. Linstowiella viviparae*. According to Szidat, the first two species belong to the "Tetis" subgroup while the latter differs from hitherto described species in regard to the excretory pattern (nine pairs of flame cells in the body, three pairs in the tail) and hence belongs in a distinct "Vivipara" subgroup. Two other cercariae possibly belonging to Sewell's Group 3 have been described by Leiper and Atkinson (1915) and Petersen (1932). The descriptions of these species are not sufficiently complete, however, to determine if they are distinct from other members of the group.

From the above review of the literature, it is seen that five subgroups have been proposed for 11 species of cercariae belonging to Group 3 of Sewell. *C. kentuckiensis* cannot be assigned to any one of these subdivisions as defined at present. The writer is convinced that all members of the group are closely related and that the erection of an additional subgroup would only complicate further a temporary classification. For this reason, it is proposed that the classification of the group be redefined and simplified as follows:

Group 3 Sewell, 1922.

a. Furcocercous, pharyngeate cercariae with long or moderately long furcae.
b. Acetabulum rudimentary or lacking; eye-spots absent.
c. Excretory system with two pairs of ascending canals, one lateral and one median, the latter pair uniting anterior to the genital primordium to form a single median canal which bifurcates anterorly, connecting with the lateral ascending canals.
d. Develop in elongate sporocysts parasitizing freshwater and marine gastropods.
e. Adult stages members of the family Strigeidae Railliet.

1. Vivax Subgroup Sewell, 1922 *(emend.)*

a. Furcae each provided with a fin-fold continuous around its distal end.
b. Acetabulum small and rudimentary.
c. Nine to 15 pairs of flame cells in the body, three pairs in the tail-stem.
Includes:
C. Prohemistomum vivax (Sonsino), life cycle by Azim (1933).
Syn. *C. vivax* Sonsino, 1892, ex *Cleopatra bulimoides, Melanopsis praemorsa.*

(?) C. *vivax* Sons. as described by Wesenberg-Lund (1934), *ex Bithynia tentaculata.*
(?) C. *sp.* Wesenberg-Lund, 1934, *ex Bithynia tentaculata.*
(?) C. *vivax* Sons. as described by Callot (1936), *ex Melanopsis pseudoferussaci.*
C. *indica* XV Sewell, 1922, *ex Melanoides tuberculatus, M. lineatus.*
C. *indica LVIII* Sewell, 1922, *ex Paludomus baculus.*
C. *leptoderma* Faust, 1922, *ex Viviparus quadratus.*
C. *vivax* Langeron, 1924, *nec* Sonsino.
Syn. (?) Cercaria of *Prohemistomum joyeuxi* Hughes, as postulated by Joyeux and Baer (1934).
C. *dorsocauda* Tubangui, 1928, *ex Ampullaria langunaensis.*
C. *Linstowiella viviparae* Szidat, 1933, *ex Vivipara vivipara.*
C. *kentuckiensis* Cable, 1935a, *ex Goniobasis semicarinata.*
(?) C. "*R*" McCoy, 1928, *ex Cerithium litteratum.*

2. Tetis Subgroup Sewell, 1922 *(emend.)*
a. Furcae without fin-folds; acetabulum lacking.
b. Two pairs of flame cells in the tail-stem.
Includes:
C. *indica XXXIII* Sewell, 1922, *ex Paludomus baculus.*
C. *curonensis* Szidat, 1933, *ex Bithynia tentaculata.*
C. *balthica* Szidat, 1933, *ex Bithynia tentaculata.*

3. Tauiana Subgroup Szidat, 1933 *(emend.)*
a. Furcae without fin-folds; acetabulum lacking.
b. No flame cells in tail-stem.
Includes:
C. *tauiana* Faust, 1930, *ex Bithynia fuchsiana.*
(?) *Furcocercaria no. 4* Petersen, 1932, *ex Paludina vivipara, P. fasciata.*
Syn. (?) *Furcocercaria no. 4* Petersen, as described by Wesenberg-Lund (1934), *ex Bithynia tentaculata.*

Three species presumably belonging to Group 3, two reported by Leiper and Atkinson (1915) and *Dicranocercaria utriculata* Lutz, 1933, are too poorly described to refer them provisionally to any of the above subgroups. Lutz (1933) refers to a figure of *D. utriculata* but a careful examination of his paper shows that such a figure is not to be found.

Cercaria ornatostoma Cable, 1935b
(Figs. 2, 3, 7, 14)

Host: *Goniobasis semicarinata.*

Locality: Scaffold Cane and Cowbell Creeks, Madison Co., Ky.

Specific diagnosis: Echinostome-like cercaria without a collar of spines. Body moderately extended 0.2 mm. long and 0.08 mm. wide; tail 0.17 mm. long. Oral and ventral suckers subequal in size. Perioral ring of about 12 large cells; a single row of inwardly directed spines just anterior to mouth and another row of eight larger retrorse spines across the ventral surface of the body midway between the mouth and the beginning of the prepharynx. Ventral sucker within posterior half of body; its opening surrounded by about forty blunt spines on the inner margins of as many radiating lappets. General body cuticula finely granular and unarmed. Numerous gland cells with rod-shaped granules; about eight openings anterior to mouth, ducts not observed. Prepharynx 0.012 mm. long; pharynx 0.019 mm. long by 0.017 mm. wide; esophagus long, bifurcating just anterior to ventral sucker; intestinal ceca extending to the excretory vesicle. Genital primordium a mass of nuclei posterior to ventral sucker connected with a smaller mass anterior to the sucker by a band of nuclei. Excretory vesicle thin-walled and bipartite, with pulsatile posterior chamber and anterior chamber giving rise to a short median stem which divides, sending large ascending trunks filled with refractile concretions almost to the oral sucker. Here the trunks loop

back, forming the recurrent tubules. Flame cell pattern not determined. Develop in rediae with collar, locomotor processes and long intestine; birthpore behind collar.

Cercaria ornatostoma is photonegative and swims almost continuously with the body strongly contracted (Fig. 14) to about 0.1 mm. in length and the tail extended to a length of over 0.275 mm. In creeping movements observed when mounted for study, the body may be extended to a length of over 0.3 mm. and the tail strongly contracted (0.135 mm. long) with its surface crenated (Fig. 7).

The most conspicuous structures of the living cercaria are the lateral glandular fields, which are yellowish in color, and the large refractile concretions of the ascending excretory trunks. The trunks are dilated with these concretions from about the mid-acetabular level to the pharynx. The details of the excretory system are obscured by the gland cells which occupy the larger portion of the body region. The posterior chamber of the excretory vesicle appears to lie between the base of the tail and the posterior end of the body. An excretory pore has not been definitely observed. An excretory tubule seems to extend into the tail for a short distance, but bifurcation or lateral openings were not observed. It is possible that the excretory wastes escape at the base of the tail and that the adult stage may retain only the anterior chamber of the excretory vesicle, the posterior chamber being obliterated when the tail is lost.

The oral sucker averages 0.038 mm. in length by 0.041 mm. in width; it is not protrusible and the opening is subterminal. The walls of the intestinal crura are thin and smooth; the ceca are observed with difficulty. The acetabulum is well developed and powerful, measuring 0.04 mm. long by 0.048 mm. wide. In specimens averaging 0.2 mm. in length, the anterior margin of the acetabulum is an average of 0.072 mm. from the posterior end of the body.

In addition to the conspicuous lateral fields of gland cells, similar cells are found in the median body region just beneath the cuticula. Like those of the lateral fields, these cells are provided with rod-like granules which tend to obscure many details of body structure.

The genital primordium, observable only in stained preparations, consists of masses of small nuclei immediately anterior and posterior to the acetabulum and connected by a band of similar nuclei. No differentiation into testicular or ovarian masses was observed.

The intestine of the redia extends almost to the locomotor processes and is filled with orange-yellow material in living unstained specimens. Young rediae are quite motile. Only rediae giving rise to cercariae were found. Encystment of the cercariae was not observed.

C. ornatostoma agrees in its general structure with the echinostome cercariae but lacks the typical collar of spines of that group. Only a few species of cercariae of this type have been described and the adult stage of only one of these has been reported. Van Beneden (1861) described what he believed was the cercaria of *Himasthla militaris* (Rudolphi) and observed that the collar spines first appeared in the metacercarial stage. In the cercariae the digestive ceca were developed and the tail was provided with prominent

lateral fin-folds. Cort (1914, 1915) described *C. reflexae,* which resembles Van Beneden's species with the exception that the fin-fold is dorsoventral instead of lateral. Other species resembling *C. ornatostoma* are *C. fusiformis* O'Roke and *C. penthesilia* Faust from the United States, *C. agilis* Filippi and *Echinostome Cercaria no. 2* Peterson from Europe, *C. redicystica* Tubangui from the Philippines, *C. sudanensis 3* Archibald and Marshall from Africa, and *C. Indica XLI* Sewell from India. In the species described by Petersen, the conspicuous excretory trunks are probably misinterpreted as intestinal ceca since he describes the pharynx as being posterior to the intestinal bifurcation.

Sewell (1922) erected the "Agilis" and "Reflexae" groups to contain the echinostome-like cercariae known at that time, and postulated that *C. fusiformis* O'Roke and a form described by Sonsino (1892) probably belonged to a third group. He characterized the two groups as follows:

The "Agilis" group:

(1) The cercariae are large, having a body-length of 0.4 to 0.6 mm. The body is oval or pyriform in shape, tapering somewhat at the anterior end.

(2) The survace of the body beneath the cuticle is crowded with rounded cystogenous cells, which contain rod-like granules.

(3) The oral sucker is situated anteriorly, but there are no collar-spines as in true echinostomes. The acetabulum is situated one-third to one-fourth the body length from the posterior end.

(4) The mouth leads back into a short prepharynx which is followed by a well-developed pharynx, but behind this there is no trace of oesophagus or intestinal ceca.

(5) The excretory bladder is divided into anterior and posterior chambers by a transverse constriction. The main excretory canals arise from the anterior chamber either antero-laterally or close together near the middle line and pass forwards to the side of the pharynx, where they bend backwards forming a loop. Contained within these canals are numerous round or oval refractile globules.

(6) The genital system consists of a median ovary and paired lateral testicular masses.

(7) Development occurs in rediae. The redia has well-marked posterior locomotor processes, and a well-developed collar. There is a rounded pharynx present which is followed by a long stomach; and a birth pore is situated just behind the collar.

Sewell included *C. agilis* Filippi and *Cercaria Indica XLI* in this group, but excluded *C. fusiformis* O'Roke and a form described and provisionally identified by Sonsino as *C. agilis* Filippi since they possessed well developed intestinal ceca.

The "Reflexae" group of Sewell resembles his "Agilis" group but its members differ in that the tail is provided with a fin-fold, erroneously described by Sewell as lateral in *C. reflexae* Cort, 1914 but indicated both by figure and by text in Cort's description (1914, 1915) as dorso-ventral in position. Sewell further characterized the members of the "Reflexae" group as having a well-developed esophagus and intestinal cecae and differing also from members of the "Agilis" group in the arrangement of the genital primordia. Sewell included *C. reflexae* Cort, 1914 and *C. Himasthla militaris* (Rudolphi), as described by Van Beneden (1861), in the "Reflexae" group. Stunkard

(1934) has shown that the cercaria of *Himasthla quissetensis* (Miller and Northup) is a true echinostome type and, for this reason, as well as the fact that no life history had been traced experimentally at the time Van Beneden did his work, it is very doubtful that the form which he had was the larva of *Himasthla militaris*.

When the structure of the described species of "echinostomoid" cercariae is reviewed, it becomes apparent that Sewell's definition of the "Agilis" and "Reflexae" groups are inadequate. Although much information has been obtained since his work was published, a natural classification of these as well as of certain other groups of gymnocephalous cercariae has not yet been afforded. The basis for the separation of groups is still uncertain; it is indeed questionable if the presence or absence of collar spines alone is sufficient basis for separating these echinostome-like species from the true echinostome cercariae which they resemble very closely in many fundamental respects. Filippi (1858) long ago expressed the opinion that the adult stage of *C. agilis* would prove to have collar spines and Van Beneden (1861) observed the development of collar spines in the metacercarial stage of a cercaria having no such spines. The profound changes that occur in post-cercarial development are well known; larval characters are lost and adult structures either appear for the first time or become fully differentiated from primordia which may develop in the cercarial stage. The actabulum of certain distome species cannot be observed in the cercarial stage and in a large number of cercariae, the intestine is lacking although it may become quite well-developed in young metacercariae of the same species. It is quite possible that further studies of the echinostome-like cercariae will ultimately result in their inclusion with the true echinostomes. Hence the writer believes it is more desirable to redefine the existing groups than to propose new groups to include *C. ornatostoma* and certain other species whose structure prevents their allocation to either the "Agilis" or "Reflexae" groups as defined by Sewell. These groups are redefined as follows:

Agilis group Sewell, 1922 *(emend.)*

a. Gymnocephalous, distome cercariae resembling true echinostome cercariae but lacking a collar of spines; body 0.2 to 0.6 mm. long, oval or pyriform in shape, and tapering somewhat at the anterior end.
b. Body with numerous unicellular cystogenous glands with rod-like granules beneath the cuticula or concentrated to form conspicuous lateral glandular fields with scattered cells beneath the cuticula in other parts of the body.
c. Mouth may be provided with spines; short prepharynx, well-developed pharynx, esophagus and intestinal ceca present or absent. Acetabulum situated one-third to one-fourth the body length from the posterior end.
d. Excretory vesicle divided into anterior and posterior chambers by a transverse constriction. Ascending excretory canals arise from the anterior chamber, either anterolaterally or from a short common median stem and extend anteriorly to either side of the pharynx where they loop backward, forming recurrent tubules. Ascending canals may be filled with refractile concretions.
e. Develop in rediae with prominent collar just in front of the birth pore, well-developed locomotor processes, and a long intestine.

Includes:

C. agilis Filippi, 1858, *ex Lymnaea stagnalis.*
C. Indica XLI Sewell, 1922, *ex Amnicola travancorica.*

C. fusiformis O'Roke, 1917, *ex Physa gyrina.*
C. sudanensis 3 Archibald and Marshall, 1931, *ex Bullinus contortus.*
C. redicystica Tubangui, 1928, *ex Ampullaria lagunaensis.*
C. ornatostoma Cable, 1935b, *ex Goniobasis semicarinata.*
(?) *C. helvetica XIX* Dubois, 1928, *ex Bithynia tentaculata.*
(?) *Echinostome Cercaria no. 2* Petersen, 1932, *ex Paludina vivipara.*
(?) *C. grandis*, Wesenberg-Lund, 1934, *ex Bithynia tentaculata.*

Reflexae group Sewell, 1922 *(emend.)*

a. Members usually smaller in size than those of the Agilis group.
b. Esophagus and intestinal ceca always developed.
c. Tail provided with fin-folds.
d. Otherwise similar to the Agilis group.

Includes:

C. reflexae Cort, 1914, *ex Lymnaea reflexa.*
C. Himasthla militaris (Rudolph) (?) as described by Van Beneden (1861), *ex Paludina vivipara.*
Syn. (?) *C. fallax* Diesing and (?) *C. pacifica* Steenstrup, as suggested by Van Beneden (1861).
C. helvetica XVII Dubois, 1928, *ex Bithynia tentaculata.*
Syn. (?) *C. obscura*, Wesenberg-Lund, 1934, *ex Bithynia tentaculata.*
(?) *C. penthesilia* Faust, 1921, *ex Goniobasis carinifera.*
(?) *C. sudanensis 1* Archibald and Marshall, 1931, *ex Bullinus contortus.*

Many additional species of gymnocephalous cercariae have certain characters in common with the members of the Agilis and Reflexae groups but seem to differ from them in one or more respects. Among those resembling the members of the above groups more closely may be mentioned:

C. semirobusta Faust, 1924, *ex Planorbis confusus.*
C. Psilotrema spiculigerum Muhling, life history by Mathias (1925).
Syn. *C. tuberculata* Filippi, 1858, *ex Bithynia tentaculata.*
C. Fasciola hepatica Linnaeus, as described by Wesenberg-Lund, (1934), *ex Lymnaea spp. et al.*
C. papillosa Filippi, 1858, *ex Bithynia tentaculata.*
C. helvetica XVIII Dubois, 1928, *ex Bithynia tentaculata.*
C. nefzaouia 1 Callot, 1936, *ex Bullinus contortus.*

Cercaria trichoderma Cable, 1935b

(Figs. 4, 9, 10, 11, 12)

Host: *Goniobasis semicarinata* (Say)

Locality: Scaffold Cane and Cowbell creeks, Madison Co., Ky.

Specific diagnosis: Cotylocercous distome cercaria; moderately extended body 0.305 mm. long by 0.123 mm. in maximum width just anterior to acetabulum. Tail sucker-like, 0.053 mm. long by 0.037 mm. wide. Delicate cuticular "hairs," 0.015 mm. long, set in elevated papillae, scattered over body and surrounding mouth; about five irregular rows of spines surrounding opening of acetabulum, similar spines around mouth. Oral sucker 0.054 mm. long by 0.048 mm. wide; acetabulum 0.046 mm. long by 0.062 mm. wide, anterior margin about middle of body. Prepharynx short; pharynx 0.026 mm. long by 0.023 mm. wide; esophagus 0.032 mm. long; ceca extend to excretory vesicle. Stylet simple, 0.011 mm. long. Four pairs of penetration glands with ducts opening at sides of stylet; cystogenous glands scattered through body. Thick-walled excretory bladder with ascending excretory canals looping backward before receiving collecting tubules; excretory formula 2(2+2+2+2). Genital primordium a smaller preacetabular and larger postacetabular mass of nuclei connected by a band of nuclei. Develop in elongate oval sporocysts. Encyst in a number of invertebrate forms.

Cercaria trichoderma does not swim actively; it is a bottom form and moves by inch-worm contractions, using the oral sucker and tail as means of attachment. At times, the larva assumes a vertical position with the sucker-like tail attached to the container, and extends the body in all directions from this position. When disturbed, the body contracts until it is almost spherical, measuring 0.185 mm. long by 0.183 mm. wide. If suspended in water by shaking, the larvae settle slowly with the body extended to a length of as much as 0.67 mm.

C. trichoderma will penetrate a number of forms, including *Chaetogaster sp., Tubifex sp., Euplanaria dorotocephala* and even other cercariae, including its own species and *C. kentuckiensis.* The speed of penetration seems to depend upon the resistance of the tissues penetrated. When the larva becomes attached to the surface of *Euplanaria,* the form which has been used most extensively in attempts to complete the life history, the tail is immediately constricted off and the larva penetrates the planarian in a few minutes. After penetration, cystogenous material is released and the larva is soon enclosed in a single, thin, transparent cyst membrane. The stylet gradually disappears and the intestinal ceca become well defined. The granular cells of the excretory vesicle become detached from the wall of the vesicle, round up, and may be gradually expelled into the intracystic fluid surrounding the worm. In no case that has been observed has the number of flame cells increased in the metacercarial stage. Numerous attempts to complete the life cycle have been made, feeding infected planarians and annelids to several species of centrarchid, catastomid and cyprinid fishes. In no case, however, were adult stages recovered. On several occasions, fishes were seined from the small stream where the snails harboring *C. trichoderma* occurred, and were examined for parasites. No trematodes that might be suspected to be the adult stage of *C. trichoderma* were found. This is surprising, in view of known facts concerning life histories of cotylocercous cercarie, and relating these larvae to trematodes of the family Allocreadiidae *(vide infra).* The possibility remains that *C. trichoderma* is the larva of either one of the few Allocreadiidae occurring in other than piscine hosts, or of an allocreadiid occurring in some fish that migrates up smaller streams to spawn but was not present at the time the stream was seined. A less likely possibility remains, namely, that *C. trichoderma* is not closely related to the family Allocreadiidae.

C. trichoderma differs from other known species of cotylocercous xiphidiocercariae in regard to the size and shape of the stylet, number of penetration glands, excretory formula, and the number and distribution of the cuticular papillae and their hair-like processes. As far as the writer is aware, "sensory" hairs have been described for only two species of cotylocercous cercariae, *C. micrura* Filippi, as figured by Lühe, (1909) and *C. Plagioporus siliculus* described by Sinitsin (1931a). Similar structures have been described, however, for numerous species of cercariae which do not resemble the cotylocercous cercariae in more fundamental respects.

Recent life history studies and more careful attention to the descriptions of species have proved conclusively that the microcercous cercariae represent

at least three distinct families of trematodes, the Allocreadiidae, Troglotremidae and Harmostomidae. It has also been postulated that the larvae of certain telorchiid and gorgoderid species are microcercous forms. Dollfus (1913) recognized the diversity of structure, parthenitae, hosts, and environment of cercariae "a queue en moignon." He accordingly separated what he believed to be a natural group of three species, *C. pachycerca* Diesing, *C. linearis* Lespés and *C. buccini* Lebour, and designated the group as "Cercaires Cotylicerques" with *C. pachycerca* as type. The group is characterized by Dollful as follows:

> Cercariae in simple sporocysts occurring in various organs of the visceral mass of marine gastropods; never in rediae.
> Body elongate anteroposteriorly. Oral sucker anterior, provided with a stylet near which open the ducts of the stylet glands; the glands fill a large part of the anterior region of the body.
> Excretory vesicle large, non-bifurcated, occupying nearly all of the postacetabular body region; walls of the vesicle composed of a single layer of large, apposed cells with granular cytoplasm of glandular appearance.
> Tail very short, broad at the base, and consisting of a cup with a very thick wall containing large cells. The bottom and sides of the cup, by combined movements, function as a sucker-like organ of adhesion. In this capacity, the tail is a well-developed organ. The term "de moignon" (stumpy) indicates either a poorly or an incompletely developed structure and is therefore incorrect.

Dolfuss does not include *C. micrura* Filippi, a freshwater form, in the Cotylocercous group, although, as Cort (1915) states, it agrees with the characterization of the group in other respects, and habitat alone is a questionable basis for separation.

Sewell (1922) separated the "Linearis" subgroup from the cotylocercous cercariae, defining its members as having, among other characteristics, not more than six pairs of penetration glands, undeveloped esophagus and intestinal ceca, and usually a smooth cuticula. This definition includes *C. brachyura* Lespés (=*C. pachycerca* Diesing), *C. Linearis* Lespés, *C. buccinum* Lebour and *C. indica XXXVIII* Sewell.

Stunkard (1932) has given a critical review of the literature pertaining to the marine cotylocercous cercariae and the reader is referred to his paper for this information. Three species, two marine and one freshwater, should be mentioned, however, since they are not included in the Cotylocercous Cercariae of Dollfus or the "Linearis" subgroup of Sewell. Pagenstecher (1862) described *C. cotylura* as having no stylet but stated that a refractile portion of the dorsal wall of the oral sucker might be mistaken for one. A comparison of Pagenstecher's description of *C. cotylura* with Lebour's (1911) of what she thought was *C. brachyura* Lespés indicates that the two species are synonymous; both develop in motile rediaform sporocysts in *Gibbula (Trochus) cinerea* and do not possess stylets. While there are apparently certain differences in other respects, chiefly size and the presence of unpigmented "eyespots" in *C. cotylura*, the descriptions of both species are too incomplete to rule out the possibility of synonymy. *Cercaria myzura* Pagenstecher, described from the freshwater snail, *Neritina fluviatilis*, differs from other cercariae

having a sucker-tail, in that it develops in simple rediae. Wesenberg-Lund (1934) described *C. micrura* Filippi as developing in "rediae" although he stated that the parthenita was characterized by an anterior knob-like thickening and the absence of an intestine. *Cercaria columbellae* Pagenstecher also develops in rediae in the marine mollusc, *Columbella rustica*, and has a pointed tail. Pagenstecher's (1862) figure (Fig. 2, pl. XXIX) of this species appears to have been taken from an embryonic stage and resembles closely Fig. 10, pl. XXVIII, representing a specimen of *C. cotylura* with an "abnormal" caudal appendage. The tail of *C. columbellae,* as figured and described by Pagenstecher, is conical rather than sucker-like, and if typical of mature larvae, indicates that this species is not a cotylocercous form. *C. medea* Faust, developing in motile sporocysts in *Goniobasis carinifera,* seems to have a tail resembling that of the cotylocercous cercariae, but is described as having penetration glands posterior to the acetabulum and a large bag-shaped excretory vesicle. The nature of its wall is not described.

The term "redia" has been misapplied so many times, particularly in the earlier literature, that in numerous descriptions in which the presence of an intestine is not mentioned definitely or figured clearly, the mere statement that a redial stage occurs cannot be accepted. While it is quite certain that mature parthenitae of the better known cotylocercous cercariae do not possess an intestine, many of them have motile, knob-like thickenings at one end which may be either rudimentary or degenerate pharynges. It should be pointed out that the very young parthenitae of these cercariae are almost unknown and may possess well-developed redial characters which become suppressed or obliterated during the development of the cercarial brood.

The excretory patterns of three species of cotylocercous cercariae including *C. trichoderma* are well known and have been partially described for certain other species. Stunkard (1932) has described the excretory system of *C. linearis* Lespés provis. and *C. Stunkardi* Palombi (=*C. brachyura* Stunkard, 1932, nec Lespés) and has found that the main ascending excretory trunks extend to about the acetabular level where each divides to form an anterior and a posterior collecting tubule. Each tubule receives the capillaries of two pairs of flame cells so that the excretory formula is $2[(2+2)+(2+2)]$. While the flame cell number in *C. trichoderma* is the same, the ascending canals extend forward without dividing and then backward as recurrent tubules, each receiving four pairs of flame cells (Fig. 4). Palombi's (1934) figure of *C. brachyura* Lespés shows very short lateral excretory canals extending from the median lateral regions of the vesicle and dividing almost immediately to form anterior and posterior collecting tubules. These differences in the main lateral excretory canals of marine and freshwater cotylocercous cercariae are probably significant but the excretory system is known for an insufficient number of species to make it possible to assign the majority of described forms to groups that might be separated on the basis of the excretory pattern.

The writer proposes the following classification of the microcercous cercariae based on descriptions of the larvae and life history studies. The inadequate descriptions and unusual nature of certain species make it impossible to

assign them to definite groups, and, in a few cases, the original descriptions have not been available. Sufficient information is available, however, to clarify somewhat the extreme confusion that exists. The Cotylocercous (Cotylomicrocercous) Cercariae of Dollfus and the "Linearis" subgroup of Sewell are emended and retained in an effort to simplify the literature as much as possible.

Microcercous Cercariae Lühe, 1909.

Distome cercariae with stumpy tails.

Group I. Cotylomicrocercous (Cotylocercous Dollfus, 1913, in part) Cercariae.

Tail modified to form a sucker-like organ of adhesion.

1. Linearis Subgroup Sewell, 1922 (in part).
   a. Stylet present, simple or cleft, set more or less vertically in the dorsal lip of the oral sucker; penetration glands anterior to acetabulum with ducts opening near the stylet.
   b. Excretory vesicle large, non-bifurcated, with a thick wall composed of a single layer of large granular cells which are glandular in appearance. Ascending excretory canals each divided to form an anterior and a posterior collecting tubule, or reflexed anterior to acetabulum with recurrent tubule receiving all of the flame cell capillaries.
   c. Develop in sporocysts or possibly very simple rediae(?) occurring in the visceral organs of marine and freshwater gastropods.
   d. Adult stages members of the family Allocreadiidae Stossich. Includes:

C. *linearis* Lespés, 1857, *ex Littorina littorea.*
Syn. (?) C. *linearis* Lespés as described by Lebour (1911), *ex Littorina littorea.*
(?) C. *linearis* Lespés provis. as described by Stunkard (1932), *ex Gibbula umbilicalis.*

C. *brachyura* Lespés, 1857, not preoccupied by C. *brachyura* Diesing, 1850 (see Stunkard, 1932, p. 327), *ex Trochus cinereus.*
Syn. C. *pachycerca* Diesing, 1858, *ex Trochus cinereus.*
(?) C. *pachycerca* Lespés (impossible name) as described by Pelseneer (1906), *ex Trochus cinereus.*
(?) C. *brachyura* Lespés as described by Palombi (1934), *ex Gibbula cinerea, G. umbilicalis, G. varia* and *Calliostoma zizyphinum.*

C. *Sphaerostomum bramae* (Müller)
Syn. C. *micrura* Filippi, 1858, *ex Bithynia tentaculata.*
C. *myzura* Pagenstecher, 1881, *ex Neritina fluviatilis.*
C. *buccini* Lebour, 1911, *ex Buccinum undatum.*
Microcercous Cercaria B. Kobayashi, 1922, *ex Melania libertina, M. extensa.*
Microcercous Cercaria D Kobayashi, 1922, *ex Melania sp.*
C. *indica XXXVIII* Sewell, 1922, *ex Paludomus transchorica.*
C. *searlesiae* Miller, 1925a, *ex Searlesia dira.*
C. *Hamacreadium mutabile* Linton, life cycle by McCoy (1929).
Syn. C. "*A*" Miller, 1925b, *ex Astraea americana.*
C. *Hamacreadium gulella* Linton, life cycle by McCoy (1930).
Syn. C. "*B*" Miller, 1925b, *ex Astraea americana.*
C. "*J*" Miller, 1925b probably not synonymous with C. "*I*" as suggested by Miller, *ex Columbella mercatoria.*
C. "*V*" McCoy, 1928, *ex Columbella mercatoria.*
C. *Plagioporus siliculus* Sinitsin, 1931a, *ex Goniobasis plicifera.*
C. *Plagioporus virens* Sinitsin, 1931a, *ex Flumincola virens.*
C. *stunkardi* Palombi, 1934, *ex Gibbula umbilicalis.*
Syn. C. *brachyura* Stunkard, 1932, nec Lespés.
C. *trichoderma* Cable, 1935b, *ex Goniobasis semicarinata.*

2. Cotylura Subgroup.
   a. Stylet lacking.

b. Develop in simple sporocysts occurring in marine molluscs only; otherwise similar to members of the Linearis subgroup.

Includes:

C. cotylura Pagenstecher, 1862, *ex Trochus cinereus.*

Syn. (?) *C. brachyura* Lebour, 1911, nec Lespés, *ex Trochus cinereus.*

Species of uncertain position (see discussion above):

C. columbellae Pagenstecher, 1862, *ex Columbella rustica.*

C. medea Faust, 1921, *ex Goniobasis carinifera.*

Group II Sulcatomicrocercous Cercariae.

a. Tail small, triangular, grooved ventrally.

b. Ventral aperture near posterior end of body receiving the ducts of a cluster of unicellular glands.

c. Stylet present, simple, set more or less parallel to long axis of body; numerous penetration glands present.

d. Excretory vesicle heart-shaped, thick-walled; ascending excretory trunks divided, forming flame cell capillaries.

e. Develop in simple rediae parasitizing freshwater snails.

f. Adult stages members of the family Troglotremidae Odhner.

Includes:

C. Sellacotyle mustelae Wallace, 1935, *ex Campeloma rufum.*

Syn. *C. trigonura* Cort, 1914, *ex Campeloma subsolidum.*

(?) *C. troglotrema salmincola* (Chapin), as figured by Sinitsin in unpublished drawings not seen by the writer.

(?) *C. repens* Bregenzer, 1916, *ex Bythinella dunkeri.*

Group III Chaetomicrocercous Cercariae.

a. Tail small, knob-like, spinose with a group of larger spines at the tip.

b. No ventral aperture with gland cells as in the Sulcatomicrocercous group.

c. Stylet present, simple, set more or less parallel to the long axis of the body; numerous penetration glands.

d. Excretory vesicle oval in shape and with thick wall.

Excretory pattern probably similar to that of the sulcatomicrocercous forms.

e. Develop in simple rediae parasitizing freshwater gastropods.

f. Adult stages mammalian lung flukes, family Troglotremidae Odhner.

Includes:

C. Paragonimus westermani Nakagawa as described by Kobayashi (1921), *ex Melania libertina et al.*

Syn. *C. abbrevicauda* Faust, 1922, *ex Melania ebenina.*

C. Paragonimus Kellicotti as described by Ameel (1932, 1934), *ex Pomatiopsis lapidaria.*

Group IV Obscuromicrocercous Cercariae (Sewell's "Helicis" Group of Cercariaea in part)

a. Tail very small, cap-like, often indistinctly separated from body.

b. Stylet lacking, pharynx present.

c. Excretory vesicle small, thin-walled, usually extending into the tail with paired openings at tip of tail. Ascending excretory canals extend anteriorly as far as pharynx, then posteriorly almost to the end of the body, and again anteriorly before receiving collecting tubules.

d. Develop in branched or vermiform sporocysts which sometimes have cuticular spines and sucker-like thickenings. Parasites of terrestrial mollusks.

e. Adults members of the family Harmostomidae (Brachylaemidae) Odhner. Members of the group probably related to many larvae described as cercariaea.

Includes:

C. Brachylaemus helicis (Meckel), *ex Helix arburstorum, H. hortensis, H. nemoralis, H. strigella, H. pomatia;* for description see Hoffman (1899).

C. Brachylaemus nicolli (Witenberg), life history by Joyeux, Baer, and Timon-David (1932), *ex Helicella scitula, Oxyphilus cellarius,* and *Agriolimax agrestis.*

C. Brachylaemus spinosulum (Hoffmann), hosts same as for *C. B. helicis;* for description see Hoffmann (1899).

C. Brachylaemus horisawai (Ozaki) metacercariae described from *Euhadra peliomphala* and *Philomycus bilineatus*. See Ozaki (1931) for abstract.
C. Panopistus oviformis Sinitsin, 1931b, *ex Helicodiscus parallelus*.
C. Panopistus magnus Sinitsin, 1931b, *ex Gastrodonta ligera*.
C. Ectosiphonus rhomboideus Sinitsin, 1931b, *ex Gastrodonta ligera*.
C. Panopistus pricei Sinitsin, life history by Krull (1935a), *ex Zonitoides arboreus*.
C. Brachylaemus virginiana (Dickerson), life history by Krull (1935b), *ex Polygyra thyroides*.
Syn. *C. Harmostomum migrans* Sinitsin, 1931b, nec Dujardin.
(?) *C. renale* Filippi, 1857.
(?) *C. Helicis carthusianellae* Ercolani, 1881, *ex Helix carthusianella*.

Group V Ephemeromicrocercous Cercariae.
a. Tail a knob of vesicular cells disappearing in the later stages of cercarial development.
b. Pharynx and stylet lacking.
c. Excretory vesicle without tubule extending into tail.
d. Develop and encyst in sporocysts without (?) escaping from them. Parasites of freshwater bivalve mollusks.
e. Adult stages members of the family Gorgoderidae Looss.
Includes:
C. Caloptroides macrocotyle Lühe, described by Sinitsin (1901), *ex Dreissena polymorpha*.

Sinitsin (1911) describes a transitory caudal appendage for *C. inconstans* from the marine snail, *Nassa reticulata*. This cercariaeum resembles *Cercariaeum lasium* (Leidy, 1890) (=*C. lintoni* Miller and Northup, 1926) from *Nassa obsoleta*. These species are pharyngeate, have stylets, and emerge from the molluscan host as cercariaea, thereby differing fundamentally from the ephemeromicrocercous type as defined above. It is possible that other cercariaea may have intermediate developmental stages with transitory caudal appendages. However, those that emerge from the molluscan host as tailless larvae as well as those that do not possess caudal appendages at any stage of development are retained in the Cercariaeum group for the present, although it, like the Microcercous group, is certainly not a homogeneous one, and should be divided into natural groups on the basis of life history studies.

In addition to the species of microcercous cercariae included in the above classification, an additional group may be represented by certain species developing in sporocysts occurring in terrestrial mollusks but differing apparently in fundamental respects from larvae of the Harmostomidae. The writer has not seen the original descriptions of these species, and is therefore unable to assign them definitely to any particular group. Three such species were listed by Dollfus (1913) as follows:

Cercaria limacis Moulinie, 1856 (=*C. trigonocerca* Diesing, 1858). Develop in branching sporocysts in *Arion rufus* and *Limax cinereus*.
Cercaria Helicis carthusianae Piana, 1882. Branching sporocysts in *Helix carthusiana*.
Cercariae Helicis nemoralis Piana, 1882. Branching sporocysts in *Helix nemoralis*.

Sinitsin (1931b) stated that *C. limacis* Moulinie and *C. Telorchis* sp., the adult stage of which he described from land turtles, were similar in respect to parthenitae, excretory vesicle, suckers and stylets, and differed only in that the tail of *C. limacis* was stumpy whereas that of *C. Telorchis* sp. was not. For this reason, Sinitsin did not hesitate in relating *C. limacis* to the "Telorchidae" although he had no experimetal evidence for doing so.

Cercaria vogeli Cable, 1935b
(Figs. 1, 5, 13)

Host: *Goniobasis semicarinata* (Say).
Locality: Scaffold Cane creek, Madison Co., Ky.
Specific diagnosis: Pleurolophocercous cercaria with left eye-spot frequently double in form; acetabulum undeveloped. Body spinose, pigmented, 0.35 mm. long by 0.125 mm. wide. Tail averages 0.66 mm. in length, provided with a dorsoventral finfold. Oral sucker protrusible, 0.05 mm. long by 0.048 mm. wide; mouth subterminal; prepharynx 0.03 mm. long, pharynx 0.023 mm. in diameter; intestine undeveloped. Seven pairs of penetration glands in mid-dorsal body region. Ducts divided into two median bundles of four each and two lateral of three each, all opening dorsal to mouth; cystogenous glands scattered throughout the body. Genital primordium a mass of nuclei immediately anterior to the excretory vesicle and partly overlaid by the penetration glands. Excretory vesicle not constricted, oval or slightly v-shaped, and with walls of thick, granular cells; excretory pattern not determined. Parthenitae simple, elongate rediae without collar or locomotor processes.

C. vogeli is strongly photopositive and will respond repeatedly to shadowing. When not swimming, the larvae rest on the bottom of the dish or suspended in the water, body downward, as shown in Fig. 13. When swimming, either spontaneously or as a response to shadowing, the larvae move in a short, jerky manner for a moment and then rest. *C. vogeli* emerges from the snail almost exclusively in the afternoon and early evening.

Neutral red has a selective action on the penetration glands which become bright red in color when exposed to this dye. Scattered nuclei and granules of the body and tail as well as the genital promordium are stained less intensely. The penetration glands are more or less regular in shape in living cercariae which are freshly mounted but soon become lobulated and difficult to count.

The entire body is covered with imbricated rows of spines which are larger and more numerous toward the anterior end. The dorsal lip of the oral sucker is provided with about three transverse rows of spines, the free ends of which are abruptly narrowed to form sharp terminal points. Delicate, protoplasmic, hair-like processes, similar to those described by Vogel (1934) for the cercaria of *Opisthorchis felineus*, were observed along either side of the body. In older cercariae, these processes disappear in a manner indicating their protoplasmic nature. The free ends of the processes shorten, their substance rounding into a small terminal spherule. The shortening process resembles that occurring when one end of a glass thread is melted in a flame. This shortening process continues, sometimes quite rapidly, until the process is reduced to a small sphere in contact with the cuticula of the body.

Conspicuous irregular masses of pigment are scattered through the body, giving the whole a golden brown appearance when observed with the lower powers of the microscope. With the oil immersion, the pigment masses are seen to be composed of small spherical granules. The eye-spots are composed of similar granules which more or less enclose the "lens." The single right eye-spot measures a maximum of about 0.011 mm. in diameter, the double left eye-spot about 0.011 mm. long by 0.02 mm. wide, with the greatest dimension transverse or diagonal to the long axis of the body. In some specimens, the left eye-spot does not appear distinctly doubled and both eye-spots may be somewhat irregular in shape.

The tail is set in a deep socket; the cuticula of the basal portion is elevated but slightly, giving that part of the tail an indistinctly annulated appearance. The fin-fold is prominent, beginning dorsally near the base of the tail, gradually widening to about 0.044 mm. and then narrowing to a width of about 0.015 mm. as it passes distally around the tip of the tail. The fold continues ventrally about two-fifths the distance to the base of the tail with a maximum width of 0.03 mm. Decaudation is frequently observed in living cercariae mounted for study.

The excretory pore is posterior at the base of the tail and can be readily observed when the tail is lost. Details of the excretory system could not be determined, being obscured by pigment masses and gland cells.

C. vogeli is the first freshwater species of its type to be reported from the United States. Cameron (1937) has traced the life history of a similar form occurring in Canada. The cercaria of *Apophallus venustus*, as described by him, differs from *C. vogeli* in size, number of penetration glands, nature of caudal fin-fold, and the presence of a small acetabulum and intestinal ceca in *C. Apophallus venustus*. The cercaria described by Ingles (1935) and postulated to be the larva of *Metagonimoides oregonensis* Price differs from all other members of the group in that it has a fin-fold only on the ventral side of the tail, well-developed intestinal ceca, and apparently does not leave the redia. According to Ingles, the tail is lost and development continues without a free-swimming period, the life cycle being completed apparently when the infected mollusk is eaten by the definitive host. This type of life cycle, if demonstrated, would be a very unusual one among the Heterophyidae, as Ingles states, and would indicate that the fin fold is a recapitulative structure, its reduction in development being correlated with the omission of a second intermediate host.

Lühe (1909) included cercariae of the type represented by *C. vogeli* in the Monostome group which he defined as cercariae, lacking an acetabulum, provided with a long, slender tail of simple nature and without setae, and developing in rediae. Faust (1917) divided Lühe's Monostome group into two subgroups, one containing binoculate, the other trioculate cercariae. Sewell (1922) pointed out that the Binoculate group of Faust was not a natural one and subdivided it to form five groups, with the Ephemera group (Trioculate group of Faust) making all told six subgroups of monostome cercariae *(sensu lato)*. Sewell's "Pleurolophocerca" group, to which *C. vogeli* belongs, should not be confused with the lophocercariae of Lühe, a furcocercous type having a longitudinal fin-fold along the median dorsal side of the body (incorrectly defined by Cort, 1915, as "longitudinal projections along the sides of the body"). The adults of these furcocercous larvae are now known to be members of the families Sanguinicolidae and Clinostomidae, while Stunkard (1930) and Vogel (1934) have demonstrated that the pleurolophocercous cercariae are larval stages of members of the families Heterophyidae and Opisthorchiidae. Witenberg (1929) postulated a close relationship between these families, uniting them in a superfamily, Opisthorchoidea. He later (1930) declared this name preoccupied by Faust (1929) but did

not propose a new designation of the superfamily. Faust, in a personal communication to Witenberg, argued against a close relationship of the families on the basis of miracidial structure. Vogel (1934) supported the opinion of Witenberg, however, and united the two families in the superfamily Opisthorchioidea.

The writer has good reason to believe that *C. vogeli* is the larva of a species of *Amphimerus* occurring in the gall bladder and bile duct of the snapping turtle, *Chelydra serpentina*. Studies on the life cycle of *C. vogeli* are being undertaken in the writer's laboratory and will be reported at a later date.

Vogel (1934) observed that Sewell's (1922) characterization of the Pleurolophocerca group is not entirely in accord with more recent studies. He accordingly redefined the group but the observations of Cameron as well as those of the writer necessitate certain minor changes in Vogel's characterization which is outlined with suggested changes as follows:

Pleurolophocerca Group Sewell, 1922 (emended by Vogel, 1934).

a. Distome cercariae with acetabulum fairly well defined, rudimentary, or apparently lacking in many species although the adult stages of all members of the group probably are distomes.
b. Two pigmented eye-spots in the anterior one-third of the body; irregularly distributed pigment imparting a golden brown appearance to the body in many species. Spination over entire body or limited to the anterior end where spination is always heaviest; long, "sensory" hair-like processes may be present on the body. Posterior locomotor pockets absent.
c. Oral sucker an oval or pyriform, muscular, protrusible organ; its anterodorsal edge is provided with spines used in penetrating the second intermediate host. Pharynx present at level just posterior to eye-spots; esophagus and intestinal ceca undeveloped in almost all known species.
d. Penetration gland complex median or median dorsal with ducts extending forward and passing dorsal to the oral sucker in four bundles and opening above its anterior border. Numerous cystogenous glands scattered through the body.
e. Excretory vesicle large, thick-walled, and globular, reniform or trilobed in shape.
f. Genital primordium immediately anterior to the excretory vesicle and dorsal to the acetabular primordium.
g. Tail long and powerful; provided with a dorsoventral fin-fold which is longer and wider on the dorsal than on the ventral side. The cuticula of the proximal part of the tail may or may not be distinctly elevated laterally and ventrally, and may be more or less distinctly annulated so that in many species the basal part of the tail appears to have lateral fin-folds.
h. Develop in simple, colorless rediae without collar or locomotor processes. Young rediae with a group of unicellular glands posterior to the pharynx; gland cells disappear in older rediae. Immature cercariae escape from rediae and complete development in hosts tissues.
i. First intermediate hosts, marine or freshwater prosobranch gastropods; second intermediate hosts, fishes as far as known; definitive hosts, piscivorous birds and mammals.
j. Adult stages members of the families Heterophyidae and Opisthorchiidae.

Includes:

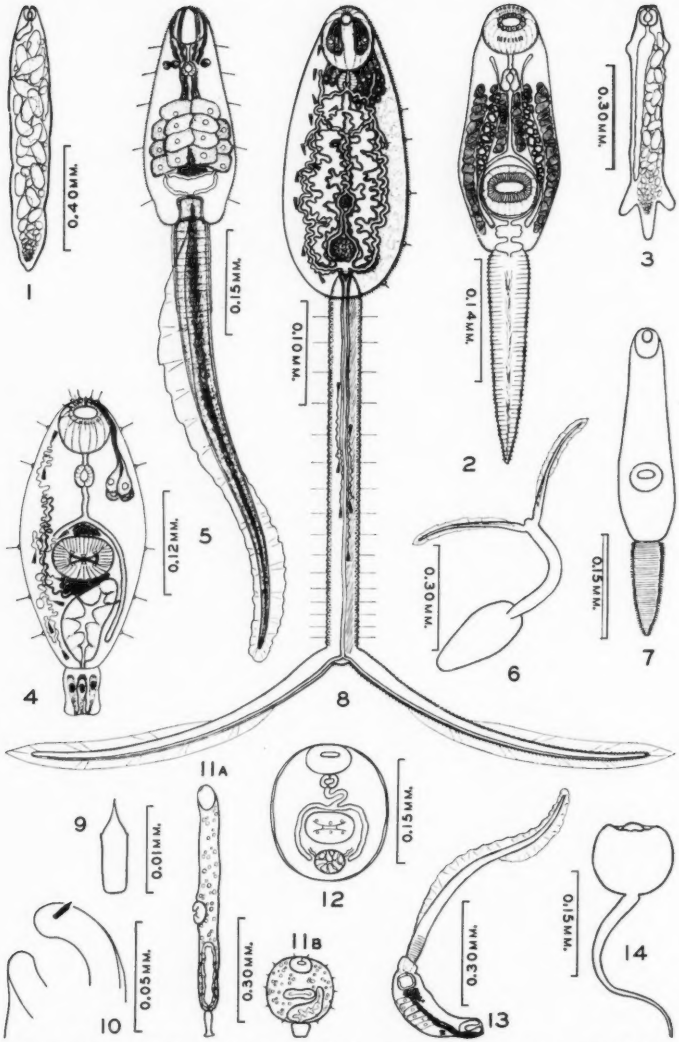
C. lophocerca Filippi, 1858, *ex Bithynia tentaculata*. Redescribed by Dubois (1928).
Syn. *C. Metorchis Intermedius* Heinemann, life history by Heinemann (1937).
C. fulvopunctata Ercolani, 1882, *ex Bithynia tentaculata*.
C. quadripterygia Sinitsin, 1911, *ex Hydrobia ventrosa*.
C. indica VII Sewell, 1922, *ex Melanoides tuberculatus et al.*
C. indica VIII Sewell, 1922, *ex Melanoides tuberculatus et al.*

C. *pleurolophocerca* Langeron, 1924, nec Sonsino, *ex Melania tuberculata.*
C. *parvomelaniae* Tubangui, 1928, *ex Melania sp.*
C. *floridensis* McCoy, 1929, *ex Cerithium litteratum.*
C. *Cryptocotyle lingua* (Creplin), *ex Littorina littorea.* Life history by Stunkard (1930).
Syn. (?) C. *lophocerca* Lebour, 1911, nec Filippi, *ex Littorina littorea.*
C. *Opisthorchis felineus* (Rivolta), *ex Bithynia leachi.* Life history by Vogel (1934).
C. *vogeli* Cable, 1935b, *ex Goniobasis semicarinata.*
C. *pleurolophocerca* Callot, 1936, nec Sonsino, *ex Melania tuberculata.*
C. *Apophallus venustus* (Ransom), *ex Goniobasis livescens.* Life history by Cameron (1937).
(?) C. *elegans* Bregenzer, 1916, *ex Bythinella dunkeri.*
(?) C. *cordata* Faust, 1924, *ex Melanoides tuberculatus.*
(?) C. *picta* Faust, 1924, nom. nov. for *Flavopunctata Cercaria B* Osafune, *ex Melania spp.*
(?) C. *benigna* Faust, 1924, *nom. nov.* for *Flavopunctata Cercaria* C. Nakagawa.

Bregenzer described spines on the dorsal and ventral sides of the tail of *C. elegans.* These "spines" are almost certainly not such at all but instead plicae in a dorsoventral fin-fold, the margin of which was not observed. From descriptions available to the writer, it is not possible to assign definitely the species questioned above to the Pleurolophocercous group. The writer has followed as closely as possible Vogel's characterization of the group which is too sharply defined to include *C. indica III* Sewell, 1922, *C. nicobarica I* Sewell, 1931, and a species described by Ingles (1935) and believed by him to be the larva of *Metagonimoides oregonensis* Price. *C. indica III* agrees with the pleurolophocercous group in all important respects except body spination and the presence of a definite fin-fold. *C. nicrobarica I* agrees with the above characterization with the exception that eye-spots and other pigment is lacking. Ingle's species has a fin-fold only on the ventral side of the tail and well-developed intestinal ceca.

The Parapleurolophocercous group of cercariae, as outlined by Sewell (1922), is closely related to the Pleurolophocercous group, its members also being larval heterophyids and opisthorchiids. It is indeed possible that if a natural classification is to be afforded, certain members of each group should be combined. On the basis of fundamental structure, certain of the parapleurolophocercous cercariae may be more closely related to pleurolophocercous forms than to other members of their own group. The cercariae of *Cryptocotyle lingua* and *Opisthorchis felineus* are almost identical in general appearance, but a careful study of the descriptions of their excretory systems (metacercarial) reveals certain important differences in respect to the division and distribution of excretory tubules. Stunkard (1929) gave a critical comparison of the excretory patterns of three species of Heterophyidae, showing that they differ greatly, both as to the number of flame cells and the arrangement and distribution of excretory tubules. Miller (1926) argued against the postulation of relationships on the basis of a single organ system. Faust (1924) assigned the same empirical excretory formula to the pleuro- and parapleurolophocercous groups but recent studies indicate that such a formula cannot be applied.

The cercaria of *Clonorchis sinensis* is a parapleurolophocercous form while



Figs. 1-14: 1. Redia of *C. vogeli*. 2. *C. ornatostoma*, ventral view. 3. Redia of *C. ornatostoma*. 4. *C. trichoderma*, ventral view. 5. *C. vogeli*, dorsal view. 6. Resting position of *C. kentuckiensis*. 7. *C. ornatostoma* with body extended and tail contracted during creeping movements. 8. *C. kentuckiensis*, ventral view. 9. Stylet of *C. trichoderma*. 10. Position of stylet in oral sucker of *C. trichoderma*. 11. *C. trichoderma*, (a) extended, (b) contracted. 12. Metacercaria of *C. trichoderma*. 13. Resting position of *C. vogeli*. 14. *C. ornatostoma* as observed during swimming movements.

that of another species of Opisthorchiidae, *Opisthorchis felineus*, is a pleurolophocercous cercaria. The same is true of two heterophyids, *Heterophyes heterophyes* and *Cryptocotyle lingua*.

The Opisthorchiidae and Heterophyidae as well as the Allocreadiidae, present a perplexing problem in the taxonomy and relationships of trematodes. The diversity of cercarial types in these families makes it exceedingly difficult to apply the recapitulation hypothesis in determining relationships. It may indeed be questioned if cercariae like the larval and embryonic stages of many animal groups, are relatively unspecialized, primitive ontogenetic stages. The cercaria has no counterpart in the life history of free-living flatworms. It has not been demonstrated that the adaptive larval characters of cercariae are older or more primitive than the structure of the adult trematode, or that convergence of cercarial structure, due to adaptations to particular types of intermediate hosts and life cycles, has been more or less profound than convergence in adult stages. The application of the principle that related digenetic trematodes have similar cercariae unites dissimilar miracidial and adult forms in the same superfamily in the case of the Heterophyidae and Opisthorchiidae while in the Allocreadiidae it may necessitate placing similar adult trematodes in separate subfamilies and even different families. While it cannot be denied that such transitory larval structures as the tail, gland cells, stylet, and eye-spots may be of phylogenetic significance, it remains to be demonstrated that they are of more importance in determining relationships than the excretory system, or the morphology of adult stages.

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BEREA COLLEGE,
BEREA, KENTUCKY,
AND
PURDUE UNIVERSITY,
LAFAYETTE, INDIANA.

New Species of Monogenetic Flukes from Illinois Fishes

John D. Mizelle

Johnson and Tiegs (1922) of Australia were the first authors to give serious taxonomic and morphological consideration to the superfamily Gyrodactyloidea. Early American workers (1900-1930) dealt almost wholly with control measures for the group from fresh-water hosts, with the result that they were never sure of the species with which they dealt. This statement is supported by the fact that Mueller (1936) recognized only one valid species viz., *Gyrodactylus fairporti* Van Cleave 1921, in America prior to 1932. Van Cleave and Mueller (1932) and Mueller and Van Cleave (1932) described three species of Gyrodactyloidea in their work on the Oneida Lake fishes. Mueller in 1934 and in later papers erected several new genera in the group and described many new species belonging to them. In 1936 and 1937 the present writer described twelve new species of *Tetraonchinae* and three new species of *Dactylogyrinae* respectively. These forms were taken from the gills of Illinois fresh-water fishes. Price (1937a & b) summarized the information on this group of flukes and the reader is referred thereto for a more complete literature review and generic lists of species.

The present author is in accord with Price with reference to the validity of the genera recently created by Mueller. It is hoped that additional information and study will provide a more concise and complete picture of the group.

Technical methods used in this investigation are given in previous publications (Mizelle 1936 and 1937).

Actinocleidus longus sp. nov.

Host: Green Sunfish *(Apomotis cyanellus)*, Embarrass River, Urbana, Illinois.

Small gill trematodes of a slightly fusiform shape, exclusive of the haptor. Length about 0.444 mm. (0.336-0.573 mm.), greatest body width near the midlength and about 0.069 mm. (0.055-0.095 mm.). Haptor discoidal in shape and well set off from the body. Eye spots four in number, posterior pair larger. Anterior bar regular in shape, and much longer than posterior bar. Length about 0.044 mm. (0.036-0.049 mm.). Posterior bar, length about 0.031 mm. (0.027-0.040 mm.). The two pairs of anchors are similar in shape, anterior anchors possess bifurcate bases, superficial root longer than deep roots. Deep roots of posterior anchors wanting. Each anchor shaft is hollow and regularly recurved without formation of an angle at junction with the point. Anterior anchors about 0.036 mm. (0.034-0.038 mm.), length of posterior anchors about 0.037 mm. (0.032-0.042 mm.). Each of the fourteen hooks is differentiated into a base, shaft, sickle shaped termina-

tion, and opposable piece. The arrangement of the hooks is as described for *Actinocleidus articularis* (Mizelle, 1936). Hook bases spherical to ovate and very short as compared with the shafts. All fourteen of the hooks are similar in shape and size, lengths about 0.013-0.017 mm. Copulatory complex well developed. Cirrus a long hair-like chitinous tube. Accessory piece solid, whip-like and much shorter than the cirrus. Vagina on the left body margin. Digestive tract as described for the genus, diameter of the pharynx about 0.026 mm. (0.021-0.029 mm.).

This species occurs in mixed infestations with *Cleidodiscus diversus* n. sp., *C. incisor* Mizelle, 1936, *Onchocleidus cyanellus* n. sp., and an undescribed species of Actinocleidus. It has been taken only from the gills of the green sunfish.

Cleidodiscus diversus sp. nov.

Host: Green Sunfish *(Apomotis cyanellus)*, Embarrass River, Urbana, Illinois.

Small gill trematodes of a slightly fusiform shape exclusive of the haptor. Length about 0.340 mm. (0.205-0.394 mm.), greatest width near the peduncle and about 0.061 mm. (0.052-0.085 mm.). Haptor hexagonal in shape and broadly connected to the peduncle. Eye spots four in number, posterior pair larger. Dorsal bar regular in shape, length about 0.021 mm. (0.019-0.023 mm.). Ventral bar variable in shape, length about 0.029 mm. (0.025-0.034 mm.). The two pairs of anchors are similar in shape and possess bifurcate bases with roots of about the same length. The anchor shafts are hollow and unite with the points with a tendency to form an angle at the junction. Length of dorsal anchors about 0.025 mm. (0.022-0.029 mm.), length of ventral anchors about 0.025 mm. (0.021-0.032 mm.). Each of the fourteen hooks is differentiated into a base, shaft, sickle-shaped termination and opposable piece. The arrangement of the hooks is as described for *Dactylogyrus bychowskyi* Mizelle, 1937. Hook bases elongate-ovate and about the same length as the shafts. All fourteen hooks are similar in shape and size, length 0.013-0.019 mm. Copulatory complex well developed. Cirrus a curved chitinous tube tapered distally, length about 0.034 mm. (0.027-0.043 mm.). Accessory piece solid, with a knob about half-way the length and generally with a bifurcate termination. Vagina on the left body margin. Digestive tract as described for the genus, diameter of pharynx about 0.21 mm. (0.017-0.027 mm.).

This species occurs in mixed infestations with *Onchocleidus cyanellus* n. sp., *Cleidodiscus incisor* Mizelle, 1936, *Actinocleidus longus* n. sp., and an undescribed form of *Actinocleidus*. It has been taken only from the gills of the green sunfish.

Urocleidus umbraensis sp. nov.

Host: Top minnow *(Fundulus notatus)*, Embarrass River, Urbana, Illinois; Kaskaskia River, Bondville, Illinois.

Small gill trematodes of a slightly fusiform shape, exclusive of the haptor. Length about 0.546 mm. (0.508-0.623 mm.), greatest body width near the

midlength and about 0.123 mm. (0.090-0.140 mm.). Haptor sub-discoidal to hexagonal in shape and broadly connected to the short peduncle. Eye spots four in number, posterior pair larger. Length of dorsal bar about 0.023 mm. (0.021-0.026 mm.). Ventral bar variable in shape, length about 0.025 mm. (0.023-0.027 mm.). The two pairs of anchors are similar in shape and possess bifurcate bases, superficial roots longer than deep roots. The anchor shafts are regularly recurved and possess a small cavity proximally. Length of dorsal anchors about 0.022 mm. (0.019-0.024 mm.), length of ventral anchors about 0.023 mm. (0.021-0.025 mm.). Each of the fourteen hooks consists of slender shaft, sickle-shaped termination and opposable piece. The arrangement of the hooks is as described for *Cleidodiscus diversus* n. sp. All fourteen of the hooks are similar in shape and size, lengths about 0.010-0.013 mm. Copulatory complex poorly developed. Cirrus a curved chitinous tube tapered distally, length about 0.025 mm. (0.019-0.030 mm.). Accessory piece short, solid, and with a knob near the distal termination. Vagina not clearly observed. Digestive tract as described for the genus, diameter of the pharynx about 0.032 mm. (0.029-0.038 mm.).

This species has been taken only from the gills of *Fundulus notatus* and is the only ectoparasite recovered from such host in this region.

Onchocleidus cyanellus sp. nov.

Host: Green Sunfish *(Apomotis cyanellus)*, Embarrass River, Urbana, Illinois.

Small gill trematodes of a slightly fusiform shape, exclusive of the haptor. Length about 0.572 mm. (0.328-0.738 mm.), greatest body width near the midlength and about 0.096 mm. (0.067-0.114 mm.). Haptor hexagonal in shape and well set from the body. Eye spots four in number, posterior pair larger. Bars regular in shape, length of dorsal bar about 0.025 mm. (0.021-0.029 mm.). Ventral bar length about 0.024 mm. (0.021-0.027 mm.). The two pairs of anchors are similar in shape and possess bifurcate bases, superficial roots much longer than deep roots. The anchor shafts are solid and unite with the points to form an angle at the junction. Length of dorsal anchors about 0.053 mm. (0.049-0.059 mm.), length of ventral anchors about 0.052 mm. (0.048-0.057 mm.). Each of the fourteen hooks consists of a long shaft, sickle-shaped termination and opposable piece. The arrangement of the hooks is as described for *Onchocleidus distinctus* Mizelle, 1936. Hook bases not evident as separate structures. All fourteen of the hooks are similar in shape, number five comparatively small, about 0.008-0.013 mm.; length of remaining hooks about 0.024-0.032 mm. Copulatory complex well developed. Cirrus a straight chitinous tube tapered distally, length about 0.035 mm. (0.032-0.040 mm.). Accessory piece small, cirral thread present. Vagina on the right body margin. Digestive tract as described for the genus, diameter of the pharynx about 0.024 mm. (0.018-0.036 mm.)

This species occurs in mixed infestations with *Cleidodiscus diversus* n. sp., *C. incisor* Mizelle, 1936, *Actinocleidus longus* n. sp., and an undescribed species of *Actinocleidus*. It has been taken only from the green sunfish.

Dactylogyrus atromaculatus sp. nov.

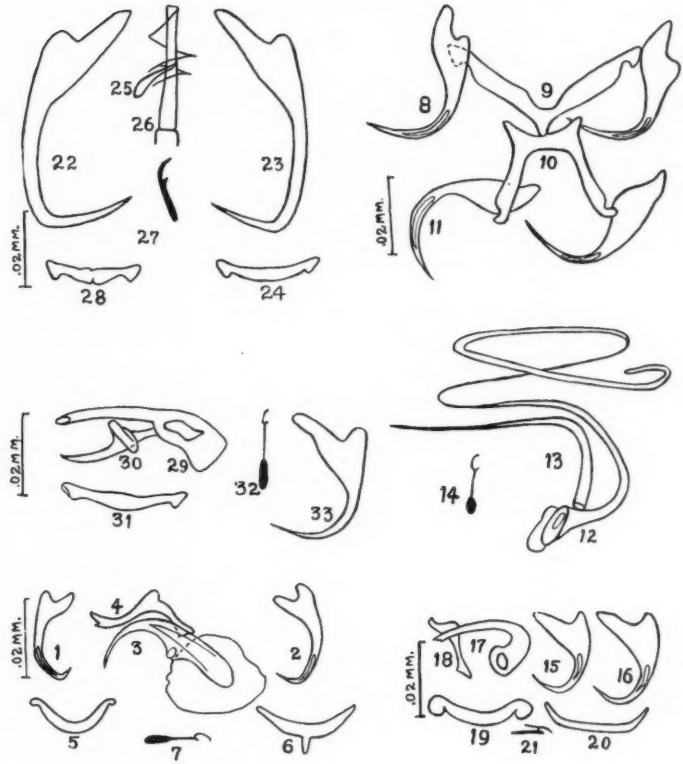
Host: Creek Chub *(Semotilus atromaculatus)*, Embarrass River, Urbana, Illinois.

Small gill trematodes of a slightly fusiform shape, exclusive of the haptor. Length about 0.526 mm. (0.385-0.656 mm.), greatest body width near the midlength and about 0.089 mm. (0.080-0.103 mm.). Haptor hexagonal or subdiscoidal in shape and well set off from the body. Eye spots four in number and all of about the same size. The single pair of anchors present are located dorsally. Length of dorsal bar about 0.029 mm. (0.027-0.030 mm.). "Klammerapparat ventrale" of German workers degenerate and only faintly visible. Anchors with bifurcate bases, superficial root much longer than deep root. Length of anchors about 0.033 mm. (0.029-0.040 mm.). Anchor shafts solid, regularly curved and without formation of an angle at the junction. Each of the fourteen hooks is differentiated into a base, shaft, sickle-shaped termination and opposable piece. The arrangement of the hooks is as described for *Dactylogyrus bychowskyi* Mizelle, 1937. Hook bases elongate-ovate and shorter than the shafts. All fourteen hooks are similar in shape and size, lengths 0.017-0.025 mm. Copulatory complex well developed. Cirrus a curved chitinous tube with a relatively large base, length about 0.037 mm. (0.025-0.042 mm.). Accessory piece solid, blade-like, and articulated to the cirrus. The vagina has not been clearly observed in this species. Digestive tract as described for the genus, diameter of the pharynx about 0.031 mm. (0.029-0.038 mm.).

This species occurs in mixed infestations with an undescribed species of *Dactylogyrus* on the gills of the Creek chub. It has been taken only from this host.

The author wishes to express his appreciation to Professor H. J. Van Cleave of the department of Zoology, University of Illinois for his encouragement and permission to use the laboratory facilities of the institution.

Type material of these forms will be deposited in the U. S. National Museum, Washington, D.C.



All drawings are drawn to the same scale and with the aid of a camera lucida.

Cleidodiscus diversus
1. dorsal anchor.
2. ventral anchor
3. cirrus
4. accessory piece
5. dorsal bar
6. ventral bar
7. hook

Actinocleidus longus
8. anterior anchor
9. anterior bar
10. posterior bar
11. posterior anchor
12. cirrus
13. accessory piece
14. hook

Urocleidus umbraensis
15. dorsal anchor
16. ventral anchor
17. cirrus
18. accessory piece
19. dorsal bar
20. ventral bar
21. hook

Onchocleidus cyanellus
22. dorsal anchor
23. ventral anchor
24. dorsal bar
25. accessory piece
26. cirrus
27. hook
28. ventral bar

Dactylogyrus atromaculatus
29. cirrus
30. accessory piece
31. bar
32. hook
33. anchor

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OKLAHOMA A. & M. COLLEGE,
STILLWATER, OKLAHOMA.

Movements and Mating Habits of the Sand Crab, Emerita analoga

G. E. MacGinitie

Feeding and General Activities

Because of the unstable conditions on sandy beaches, due to shifting sand, heavy surf, and tidal exposure, the number of species of animals indigenous to such localities is few compared with that of the more secure rocky regions. However, animals that have become adapted to the open sandy beach usually occur in great numbers of individuals, no doubt because of the lack of competition for space. As far as food is concerned, the sandy beach is capable of supporting almost as many animals as are the rocky regions, the most unfavorable factor of the open beach being the lack of protection. Practically all animals that live on the open beach seek refuge beneath the sand, and are equipped to bury themselves very quickly.

The sand crab or mole crab, *Emerita analoga* (Stimpson) (Fig. 1), which is found from Oregon to Panama, is very abundant on the beaches of Southern California. This sand crab is exceedingly well adapted to living on the open beach. It can bury itself rapidly, can swim fairly efficiently by means of the uropods, which are modified into swimming or sculling organs, and its carapace is streamlined from the flexure of the abdomen toward the head. Emeritas burrow backward, the burrowing being facilitated by the movements of the anterior pairs of legs as well as by the sculling organs, and they settle into the sand facing oceanward.

Just before the water runs back down the beach after breaking, the crabs extend their large feathery antennae (Figs. 6, 7) above the sand (Fig. 3), and strain food from the receding current of water (Weymouth and Richardson, 1912). As the tide moves up and down the beach it is necessary for the sand crabs to move up and down with it, because, in order to feed efficiently, it is necessary for them to be at such a point with reference to the tide that they are approximately near the level where the receding wash from the breaking waves will flow by them a maximum length of time. The antennae are so constructed that they will gather food particles only as the water passes through them from the dorsal to the ventral side as they are extended; therefore the crabs feed only as the water washes down the beach. (However, if the water is practically still, the crabs often create some current and thereby obtain some food by alternately waving their antennae.) Too, if the crabs are left too high on the beach they fall prey to birds, and if they are too far down the beach they fall prey to shore feeding fishes.

Although at almost any time individual crabs may be seen moving up or down the beach as the case may be, the general migration with the tide takes

place in mass movement (Fig. 4). This mass movement occurs very quickly; that is, within less than ten seconds, and is somewhat startling to the observer, for it appears that a portion of the beach comes up, moves either up or down and then disappears, yet the beach is still there, On a gently sloping beach this migration usually occurs at a time when the sand crab colony is covered with from two to six inches of water. No direct stimulus for this movement which would make it occur as a mass movement has yet been found. Perhaps some stimulating cause may be found upon further observation, or it may be necessary to explain it upon the basis of "instincts" such as cause mass movements in other gregarious animals. No doubt there are many such instinctive reactions which occur in the animal kingdom of which man has no conception. It should be noted that *Emerita* has a tendency to move down a slope only when it is out of water and out of the sand, and not in general as one would be led to believe by Mead (1917). Such mass movements of *Emerita* as have just been described take place every hour or so, the length of time between movements depending, of course, upon the difference between high and low tide; that is, during spring tides the movements are more frequent than during neap tides. The slope of the beach and the condition of the surf also have some effect upon these movements. On a steep beach the mass movement occurs oftener, especially if the surf is light, and hence the movement is not so general; that is, several migrations are necessary before all the crabs on a certain level of the beach have moved down to the new level. At the time the movement takes place the crabs emerge just as the wave starts up or down the beach, depending on whether they are moving up or down. They allow the wave to carry them (Fig. 4) until the movement of the water begins to slacken, whereupon they quickly orient themselves and dig in.

Sometimes on spring tides large patches of Emeritas may be left by the tide, particularly on gently sloping beaches. When this happens the crabs bury deeply (from three to six inches, depending upon the degree of saturation of the sand by ocean water), and await the next incoming tide. These patches of crabs left stranded by spring tides have given rise to the opinion expressed by casual observers that the crabs are always left exposed at low tides and bury in the sand while the tide is out. Sometimes after a heavy rain fresh water seepage will kill the few that are left above the receding tide.

Mead's paper (1917) contains unreliable information since he expected the animals to act naturally after having placed them in an unnatural condition. In his summary he states:

> 2. The animals tend (1) to run down slopes, and (2) to go towards the ocean, when within 200 feet at least of it, although their view of the ocean be intercepted.
>
> 3. A 7 per cent slope away from the ocean neutralizes their oceanward tendency.
>
> 4. Experiments in the air with *Emerita analoga* cannot be continued for many hours with normal responses.

It is quite obvious that summary "2" is correct, and what would logically be expected. However, contrary to his conclusion under "3," I have found

that if Emeritas are placed on a level spot under water, and a large dark object is placed between them and the ocean, they show no tendency to move toward the ocean, but will move down a slope away from the ocean if the sand-filled dish in which they are contained is sloped slightly in that direction. It seems to me that summary "4" is sufficient reason in itself for not expecting responses as obtained by Mead to apply to the responses of *Emerita* in its natural habitat. If one were to stand on the beach for 24 hours at high water mark on a shore which contained millions of *Emerita*, I doubt if within that time one would see a single *Emerita* moving on the beach where it was not within the reach of water as the water moves up and down the beach. Therefore, what use may be made of conclusions based on experiments performed on *Emerita* out of water?

To quote again from Mead:

> If a person approaches a bed of sand-crabs the antennae are all withdrawn so that concealment is most complete. Stamping had the effect of producing slight disturbances in the crab beds. These disturbances were probably due to the crawling of the animals deeper into the sand. If one stands for some time in the midst of a bed of sand-crabs, the creature remains concealed in the sand for an indefinite time.

A factor here ignored by Mead is that rather often the odor from one's boots or feet, no matter how clean they may be, may cause Emeritas to remain concealed for a long period of time. The sensitivity of marine animals to foreign substances in the water is very acute. It is a factor that one is likely to overlook unless backed by considerable field experience. Hopkins (1932) has shown that the oyster, *Ostrea virginica*, is sensitive to a 0.0000046 M solution of quinine sulfate, which is about eight times as sensitive as is man to the same substance. I believe that crustacea are very much more sensitive to foreign substances than are the molluscs. However, if one wades out into the bed of Emeritas and quietly stands there, the crabs will ultimately resume their natural activities as though one were not in the neighborhood.

Again quoting from Mead:

> This concealing action strongly suggested that the animals are frequently the prey of certain beach birds. I suspected the herring gulls, but at no time saw the gulls feeding upon them, nor could I learn from fishermen that such was ever the case. Soon after, however, I noticed flocks of sandpipers and long-billed curlews feeding ravenously upon the crabs and concluded that the concealing reaction is due to the feeding of these birds.

The concealment of *Emerita* in the sand serves no doubt as a refuge for this animal from its enemies. What led Mead to the conclusion that only birds were at fault is not clear. In the course of evolution there are many other animals which could have been as effective as birds in causing these crabs to conceal themselves in the sand. These sand crabs may have had the burrowing habit long before sandpipers and curlews became shore feeding birds. I have seen sandpipers, sanderlings, godwits, black-bellied plovers willits, curlews, scoters, and even Brewer's blackbirds feeding upon these crabs, but without disturbance to the activities of the remaining animals. The crabs

are preyed upon by animals lower in the water, and these animals perhaps had more effect upon the evolutionary choice of the burying activities of *Emerita* than had birds, for they no doubt were preying upon the crabs during the latter's evolution toward becoming sand-dwelling forms. As the waves wash down and leave some of the Emeritas "dry" they always withdraw their antennae and remain concealed under the sand whether or not there are any birds or other animals, including human beings, about. Too, the withdrawal of the antennae is part of the feeding activity, as they are drawn in to remove the collected food material after the wave passes by. The ones upon which birds feed are mainly the juveniles and males (when breeding is not general), which remain higher on the beach than do the larger individuals. (When breeding is being carried on the males perdominate in the main portion of the colony of Emeritas.) Scoters feed upon the crabs under water, and, therefore, upon larger individuals. Cancer crabs, swimming crabs *(Portunus xantusii)*, croakers, corbina and the imported striped bass feed on the oceanward side of the beds of *Emerita*. Two other sand crabs, *Blepharipoda occidentalis* and *Lepidopa myops* (for descriptions and figures, see Schmitt, 1921), which are rather common in colonies of *Emerita,* apparently do not feed upon the living crabs, but upon dead Emeritas and other dead or decaying flesh. Of one thing we can be sure, the Emeritas must remain buried to escape dessication and to hold their position in the surf.

An analysis of the environment in which an animal lives is not helped by choosing some particular factor and elaborating it, but rather in reading the conditions as they exist and have existed in the past history of the animal. In nature Emeritas have no more tendency to move up than down the beach, but to remain at an optimum position to which they have become adapted through ages of evolutionary experience. Four important factors (not to mention food, temperature, condition of the sand, surf, etc.) which cause *Emerita* to remain in this optimum position are (1) current, (2) depth of water, (3) slope of the beach, and (4) light. Any one of these factors may be artificially presented out of proportion to the other so that many responses which would be entirely at variance with natural living activities may be obtained.

For example, if a stream of salt water, say from a hose, is made to flow over the Emeritas, from seaward toward the land, they will immediately reverse their position in the sand and face toward the land, even if they must move uphill to do so. Contrary to Mead's conclusions, I find that Emeritas, when under water in a natural state, are greatly influenced by objects placed between them and the ocean, for a large black screen will cause them to face landward if the current passing over them is held to a minimum. Under natural conditions the stimulus of the current appears to be much stronger than the stimulus of sight. Hence, by keeping Emeritas in a container or a portion of the beach which is supplied with fresh salt water, one can, by controlling any two of the other major factors, cause the Emeritas to become irresponsive towards slope of the beach.

While making field observations on *Emerita* some rather interesting things

came to light regarding the proportions of males, oviferous females, and non-oviferous females on the beach with reference to tide. In May and June, during the height of the mating season along this beach, male Emeritas outnumbered the females three to one in the main portion of the active bed of sand crabs. At what was practically the end of the mating season, as shown by the number of oviferous females, a sample of sand screened from the active portion of the colony yielded 78 oviferous females, 10 non-oviferous females and 256 males. In October sand crabs were screened from a strip of beach extending from slightly below high tide mark to below the water at low tide. The results are given in the table below, in which Station 1 is just below high tide mark and Station 9 is under the water at low tide. (At Monterey Bay the breeding season checks fairly close with that at Newport Bay, although it may be two or three weeks later at Monterey Bay.)

Proportion of sexes of *Emerita analoga* from beach at Newport Bay, California, October 7, 1937.

Station number	Females			Total females	Males
	Without eggs	With eggs in early stages	With eggs in late stages		
1	1	2	0	3	0
2	27	4	3	34	21
3	27	9	2	38	42
4	49	11	7	67	98
5	45	12	1	58	34
6	6	0	1	7	12
7	16	1	1	18	2
8	22	9	7	38	4
9	98	9	251	358	27
Totals	291*	57	273	621	240

* From one third to one half of these females were juvenile.

There seems to be a decided tendency for the females that are about ready to shed their berries to stay on the oceanward side of the bed. Females outnumbered the males 2.5 to one. It will be necessary to investigate further in order to determine whether or not the number of males decreases after the main mating season is over. At least there is an indication that the males remain higher on the beach at this time than they do while mating is going on more actively. Almost daily field observation and frequent screening and counting over a period of a year would be necessary before an absolute statement could be made as to the exact proportion of males and females on the various levels of the beach with reference to tide. Field observation on the entire colony indicates that the females carry their eggs between four and five months, but this has not been checked with individuals under control.

Mating Habits

Male Emeritas are much smaller than the females, averaging about half the length of the females. Deposition of sperm usually takes place about twelve hours before the eggs are laid, and may or may not occur at the time

of molting. In general, mating takes place in late spring or early summer, though oviferous individuals may be found throughout the year. Males apparently sense the approaching time for egg laying by the female, and they gather around her for as long as two to five days before, and are very persistent in their attempt to remain in contact with her. Often when the mass movements up and down the beach take place, females which are about ready to lay eggs will be accompanied by a considerable number of males, and some two or three of them may even be attached to the female, and, therefore, be carried with her instead of moving with her under their own power. They attach to the female by the dactyls of their fourth legs, which are equipped with a sort of sucker pad surrounded by stiff hairs (Fig. 5). Sometimes they hold on with both of these dactyls, at other times with only one. As viewed under the microscope, the sucking pad with its surrounding hairs does not look very efficient, but the ease with which the males cling to the female is surprising, for they have merely to place the dactyl against any part of the carapace or appendage of the female to attain a hold. However, the clinging is voluntary and not automatic.

As a female buries in the sand the males have a tendency to collect on her ventral side where later the sperm will be deposited. When such a female with her retinue of males settles into the sand, males buried in the surrounding sand rush toward the female and bury themselves by her. At the time of mating, when the males are facing toward the ventral side of the female, is, as far as I know, the only time that all individuals along the beach are not facing the open sea while they are buried. Of course, eddy currents near rocks or other deflecting surfaces may cause the nearby crabs to take up a position not directly facing the surf line.

As stated above, eggs may or may not be laid immediately after a female molts. In several instances males were observed depositing sperm on the ventral side of females which had just molted. When molting does not take place, it is difficult to ascertain exactly how many males mate with the female, but surely more than one. The sperm is attached to the female by a sticky, thick, ribbon-like mucus. When a portion of this ribbon (Fig. 8) is removed and placed under a microscope, the spermatozoa are seen to be in packets regularly arranged within the ribbon (Fig. 9). Soft-shelled females upon which sperm has just been deposited have been brought into the laboratory, and in all cases they became oviferous during the night, and by the next morning their shell had hardened and they had resumed feeding. Occasionally a soft-shelled female may be found lying on top of the sand in the act of mating with males. In such cases the female lies on her back with the abdomen unflexed, and while she is in this position from two to four males deposit sperm on her ventral surface in the crevice between the third and fourth pair of legs. Usually a portion of the ribbon of sperm is not utilized, but this disappears in about 24 hours after the last eggs are laid. In one instance a hard-shelled female which had just deposited eggs on the two posterior pairs of pleopods was broughe into the laboratory. Eggs were not deposited on the remaining pair of pleopods until three days later. During

this time the ribbon of sperm remained intact, but it disappeared within 24 hours after the last eggs were laid. Ordinarily all three pairs of pleopods are filled with eggs in one continuous operation. Mating usually takes place when the female is buried upright in sand under water or in saturated sand. While depositing sperm the male faces the female with his body at an angle of about 45 degrees with hers.

Sex Recognition

From his observations on the Blue Crab *(Callinectes sapidus),* Hay (1905) was of the opinion that the male is able to distinguish the female that is about to molt, since he seizes one and carries her about with him for several days preceding molting, and mates with her immediately after she molts. I made the same statement with reference to hermit crabs (MacGinitie, 1935, p. 712), which conduct themselves in a manner similar to that of Blue Crabs prior to molting and mating. But, from his observations and experiments with amphipods, Holmes (1903) concluded that sex recognition in this group is neither by sight nor smell, but that the males have an instinct to grasp and carry other individuals, whereas the females possess the instinct to remain quiet when seized. Others, such as Andrews (1904, 1910), Chidester (1908, 1912), Dearborn (1900), and Pearse (1909) concluded from their work with the crayfish that sex recognition is largely tactual and kinaesthetic, due to the difference in behavior and lack of resistance on the part of the female. As a result of his work on four brachyuran crabs Chidester (1911) stated: "I now hold that the ability of the male crab to distinguish the sexes is really a matter of inability to hold and copulate with the male individual. It seems that discrimination is tactual and kinaesthetic." He found that males removed from soft females while copulating would attempt to copulate with hard males as well as with egg bearing females, which successfully resisted the males.

Among many marine animals, such as certain worms, echiuroids, sipunculids, starfishes, sea urchins, oysters, clams, and others, spawning by one animal will stimulate spawning by practically all members of the colony. The substance which stimuates the chemotropic sense concerned with spawning must in many cases be exceedingly dilute.

In the case of insects it can be said that there are two or three ways in which the male instinctively recognizes the female, e.g., wing vibration in mosquitoes, or odor in butterflies, and, in one case at least (the water bug *Belostoma),* the female searches for the mate. Male dung flies, *Scatophaga stercoraria* (Linn.), try other individuals one after another, though but for a second. When this trial and error process enables a male to find a receptive female, copulation follows. However, in the trial and error activities of the male, I have never noticed any resistance on the part of other males or nonreceptive females.

Chidester (1911) further states that the males of the four species of crabs with which he worked made no attempt to mate with females of another

species. If a male can distinguish between females of his own and a different species he can surely distinguish between males and females of his own species, in case the latter are ready to lay. Because he found that amphipods with their eyes and antennae removed would still grasp females, Holmes (1903) concluded that the selection is because the males instinctively grasp other individuals and the females instinctively become quiescent when seized. Anyone who has worked on the habits of marine crustacea very long knows that the chemotropic sense is not confined to the antennae, but is located on any part of the body of the animal where there are sensory hairs, especially the dactyls.

From the observations on *Emerita* given above it is obvious that the recognition of the females by the males is not due to the lack of resistance of the females, since they cling to a female while she is very active. In no case were males observed to cling to other males for more than a fleeting instant. While mating is going on the males surely possess the instinct to cling to an object, but when a male places his clinging dactyl on another male or an egg-bearing female they are immediately released. It would be difficult to explain why males emerge from the sand and gather around a female *Emerita* with her retinue of males if it is not due to a chemotropic or similar sense. They do not thus emerge and settle around other males or egg-bearing females, so with *Emerita* it can not be a tactual sense. A group of males will cling to a female for from two to five days prior to mating.

The idea of quiescence alone on the part of the female being the only stimulus which enables a male crustacean to determine a female for copulatory purposes is amusing to say the least. After all, quiescence on the part of the female is a part of the game among animals, up to and including man. Why does a male hermit crab drag a female around for days before mating? A small hermit will withdraw into a shell and remain passive when molested by a larger hermit, yet the larger hermit will not drag a smaller male about. If two male hermit crabs meet while one of them is dragging a female, a battle follows, after which the victor will grab the shell of the female and make off with it. He does not stop to investigate whether or not the female is passive. And why do certain crustacea pair permanently if they can not recognize the opposite sex? (MacGinitie, 1937).

Species of animals and individual animals of a species differ from each other in certain characteristics according to the curve of normal distribution. The expansion of the binomial as applied to animal traits should always be kept in mind when dealing with even the lowliest animals. This curve helps one to visualize variation in conformity with the present day knowledge of genetics, and upon variation depends adaptive deployment and evolution. I once saw a male *Hyla* clasp a salamander, *Triturus torosus*, and cling to it for more than three days. But *all* the male *Hyla* in the pool did not clasp these salamanders. Because crayfish have a tendency to "try out" every individual of their species they meet with, thus giving the impression that passivity is the only stimulus for sex recognition (Pearse, 1909), it does not necessarily follow that all other species of crustacea do the same. Certainly

this is not true of many species of crustacea which I have studied, e.g., *Emerita analoga, Pagurus samuelis, Upogebia pugettensis, Callianassa affinis,* and others.

Summary

1. *Emerita analoga* is found in maximum numbers within a zone which affords them the greatest opportunity for collecting food from the water washed down the beach after each incoming wave. This zone moves up and down the beach as the tide moves in or out.

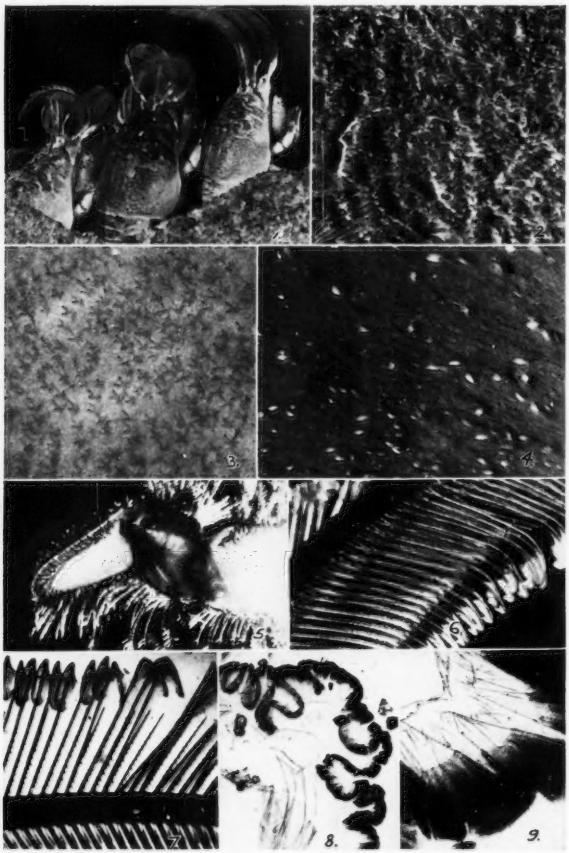
2. Movements up or down the beach takes place *en masse,* though under certain conditions this may not always be so.

3. The main factors which keep the sand crab at a certain level are (1) current, (2) depth of water, (3) slope of beach, and (4) light. Any one may be artificially presented out of proportion to obtain responses at variance with natural conditions.

4. Condition of surf, food, temperature, and degree of coarseness of the sand are other important factors. Enemies, while a factor, are less important.

5. Mating takes place in late spring or early summer, the females becoming oviferous soon after the deposition of sperm by one or more males.

6. Evidence is given which indicates that sex recognition plays an important part in mating.



FIGURES

1. *Emerita analoga* feeding in an aquarium. Bodies more exposed than normally. Current from left to right. x1.
2. "Bed" of Emeritas just before break runs up the beach.
3. Same, just before water starts down. Antennae have just been extended. Depth of water, 10 inches.
4. Mass movement to a lower level. 1/500 sec. exposure at 4.5 feet.
5. Dactyl of fourth leg of male. x20.
6. Portion of antenna. Dark field to show fine cilia-like hairs between "barbs."
7. Same, to show reinforcing "barbs" and feathery ends of food collecting "barbs." x20.
8. Ribbon of sperm. x10.
9. Same, showing arrangement of sperm. x60.

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KERCKHOFF MARINE LABORATORY,
CORONA DEL MAR, CALIFORNIA.

Brissopsis blanpiedi, a New Species of Echinoid from the Medial Tertiary of Mississippi

U. S. Grant, IV. and L. G. Hertlein

Specimens of a species of echinoid from the medial Tertiary of Mississippi were presented to us for study by Mr. Merle C. Israelsky, Paleontologist with the United Gas Corporation, Houston, Texas. To him we express our appreciation for the opportunity to study these specimens and for his cooperation and suggestions. Mr. Israelsky's opinion that the species was new proved to be correct and we here describe it as *Brissopsis blanpiedi* in honor of Mr. B. W. Blanpied who originally presented these interesting specimens to Mr. Israelsky. We wish to acknowledge the assistance of Professor Hubert Lyman Clark of the Museum of Comparative Zoology, Cambridge, Mass., for critical remarks on these fossils and loan of a specimen of *Brissopsis luzonica* from Japan.

There has been some difference of opinion regarding the age of the beds in which these specimens were found. They were collected from the bentonite bed in the basal Bucatunna of Smith County, Mississippi. The Bucatunna has been considered to be of Byram, Oligocene age by J. T. McGlothlin, geologist for the Gulf Refining Company of Louisiana in 1930. This was mentioned in the Guidebook of the Eleventh Annual Field Trip of the Shreveport Geological Society in Southeast Mississippi, compiled by Roy T. Hazzard and B. W. Blanpied (50 pp., maps, charts, 6 pls., 1934).[1] The formation is described as a "sequence of bentonitic clays, bentonite, and cross-bedded sand," and the successive transgression of the Bucatunna across the Vicksburg from Marianna to Byram is demonstrated for the region discussed. Israelsky[2] has given a critical review of the guidebook and cited two correlation tables, one by M. A. Hanna and Gravell in which the Bucatunna is placed in the Oligocene, and another table by Israelsky in which the Bucatunna is placed in the Lower Miocene.[3] Without entering further into the general problem of the age of the beds, there is one factor which should be considered. This is the great resemblance of the new species to *Brissopsis atlantica* Mortensen, a Recent species from the Atlantic, and *Brissopsis luzonica,* a Recent species

1 See also Blanpied, B. W., and Hazzard, R. T. The Age and Correlation of Chickasawhay and Bucatunna members of the Catahoula, Wayne County, Mississippi. Amer. Assoc. Petrol. Geol. Annual Meeting. Los Angeles, California, March 17, 18, 19, 1937. Program: 53. See also Cooke, C. W., Notes on the Vicksburg Group, Bull. Amer. Assoc. Petrol. Geol. **19**(8):1162-1172 1935; and, Gulf Coast Oil Fields; 358-368, Tulsa, 1936.

2 Bull. Amer. Assoc. Petrol. Geol. **19**(4):574-575, 1935.

3 Mr. Israelsky, in letter of Sept. 10, 1937, suggests that the beds containing the *Brissopsis* can well be considered as of Catahoula age, that is, Florida Miocene.

from the Indo-Pacific region. This might suggest a later rather than earlier geological age for the beds containing the fossil echinoid.

Genus BRISSOPSIS L. Agassiz

Brissopsis L. Agassiz, Cat. Syst. Ectyp. Echin. Foss. Mus. Neocom., pp. 3, 16, 1840. Sole species: "*elegans* Ag." "Craie à hippur. Royan." [In Ann. Sci. Nat., Ser. 3, Zool., **8**:15, 1847, L. Agassiz & Desor cite the species as from "Terr. Numm. de Royan, de Montfort près Dax. Tert. de Saint-Estèphe (Gironde).—D'orbigny, Desmoulins, Delbos." *Spatangus grignonensis* Desmar. in Desml. (Tabl. Syn. p. 390), is cited as a synonym]. *Brissopsis elegans* is figured by Cotteau, Paléont. Franc. Ser. 1 (Anim. Invert.), Terr. Tert. **1**, (Échinides Éocènes): 184-187, pls. 52, 53, 1884-1889. "Localité.-Saint-Estèphe, Blaye (Gironde). Très rare. Éocène supérieur." [*Spatangus grignonensis* (non Desmarets), Des Moulins, Études sur les Échinides: 290, 1836, is cited in the synonymy].—Lambert, Mem. Soc. Geol. Franc., Paleo. Mem. No. 24 (**14**, fasc. 2-3): 104-108, 1906. Type: *Brissopsis elegans* L. Agassiz.—Lambert & Thiéry, Essai Nomencl. Raison. Echinid., fasc. 6 and 7, p. 489, Dec. 1924. Type: *Brissopsis elegans* L. Agassiz.—H. L. Clark, Cat. Rec. Sea-Urchins Brit. Mus.: 212, 1925. "Type, *Brissus lyrifer* Forbes."

Toxobrissus Desor, Syn. Echin. Foss.: 399, 1858. Species cited: *Toxobrissus elegans* Agassiz (*Brissopsis elegans* Agassiz); *Genei* (*Brissopsis genei* Desor); *michelotti* Desor; *crescenticus* (*Brissopsis crescenticus* Wright); *latior* (*Brissopsis latior* Herklotz). Type here designated (Grant & Hertlein): *Brissopsis elegans* L. Agassisz. [The type is designated by the present authors thus making *Toxobrissus* an absolute synonym of *Brissopsis*].

Peristome elongate transversely; peripetalous and subanal fascioles (but no internal fasciole) present; ambulacra petaloid, III depressed and only dorsally petaloid, I and V generally shortest.

This well-known genus is widely distributed in the Recent Seas, and Lambert & Thiéry[4] cite eleven species from the Eocene.[5] *Kleinia* Gray[6] typified by *K. luzonica*, is probably better considered to be a synonym[7] than a subgenus.

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4 Essai Nomencl. Raison. Echinid., fasc. 6 and 7: 489, Dec. 1924.

5 It is present in the lower Eocene [not Paleocene] of India.

6 Ann. & Mag. Nat. Hist., Ser. 2, **7**: 133, 1851. Only species *K. luzonica* Gray, from "Phillipines, Isle of Luzon." Recent. This is a wide-ranging Indo-Pacific species, occurring in the Hawaiian Islands but not known east thereof. See also H. L. Clark, Mem. Mus. Comp. Zool. **46**(2):204-206, pl. 152, figs. 5, 6, 7, 8 [figs. of holotype of *Brissopsis circosemita* A. Aggasiz & H. L. Clark, here considered by Clark as a young individual of *B. luzonica*], pl. 155, figs. 2 and 3, 1917. Numerous localities in Hawaii and Japan.

7 A. Agassiz, Illustr. Cat. Mus. Comp. Zool. **7**(2): [Mem. Mus. Comp. Zool. **3**], p. 354, 1872. "Kleinia, as based upon the original specimen *(Kleinia luzonica)* of Gray, certainly is nothing but a *Brissopsis*, having a most distinct subanal fasciole."

Zeugaster Lambert (Mém. Soc. Géol. France, Paléo. Mém. No. 24 (**14**, fasc. 2-3): 106,1906) with the "Type: *Z. Lamberti* Guathier *(Brissopsis)*," is a near synonym.

Brissopsis blanpiedi sp. nov.

Figs. 5-6, 8-10

Description. — Test somewhat elongate, depressed, height at posterior end, about 40% of length, with a shallow rounded notch at Amb. III, posteriorly nearly vertically truncated, but periproct just visible from above; all ambulacra depressed, the posterior pair contiguous proximally; posterior row of pore pairs in I and V and anterior row in II and IV becoming gradually reduced proximally, poriferous areas of V indistinct or greatly reduced, pores apparently single; peristome reniform. Length 31 mm., width 24 mm., height 15 mm.

Fig. 1. *Brissopsis luzonica* Gray. A reproduction of figure given by H. L. Clark (Mem. Mus. Comp. Zool., Vol. 46, pl. 152, fig. 5, 1917), off Puniawa Point, Maui, Hawaiian Islands; Recent. Abactinal view. Figures 1, 2 and 4 represent the holotype of *Brissopsis circosemita* A. Agassiz & H. L. Clark, which Clark considered to be a synonym of *luzonica*.

Fig. 2. *Brissopsis luzonica* Gray. A reproduction of figure given by H. L. Clark (Mem. Mus. Comp. Zool., Vol. 46, pl. 152, fig. 7, 1917). Actinal view of specimen shown in fig. 1.

Fig. 3. *Brissopsis luzonica* Gray. Hypotype in Mus. Comp. Zool. Harvard University. Japan; Recent. Abactinal view.

Fig. 4. *Brissopsis luzonica* Gray. A reproduction of figure given by H. L. Clark (Mem. Mus. Comp. Zool., Vol. 46, pl. 152, fig. 6, 1917). Right side view of specimen shown in fig. 1.

Fig. 5. *Brissopsis blanpiedi* Grant & Hertlein, n. sp. Holotype No. 7171 (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 28721 (C.A.S.), from four foot bed of bentonite which overlies the basal manganiferous zone of the Bucatunna formation which overlies the Glendon or Marianna limestone: NW corner of NE ¼ of Sec. 32, T. 4 N., R. 8 E., Smith County, Mississippi, about 8 miles north of Raleigh. The outcrop is about 200 yards east of highway No. 35 on Glaze farm.

Note the similarity shown in figures 5, 8 and 9 when compared to *Brissopsis luzonica* shown in figures 1 and 3.

Fig. 6. *Brissopsis blanpiedi* Grant & Hertlein, n. sp. Actinal view of the specimen shown in fig. 5.

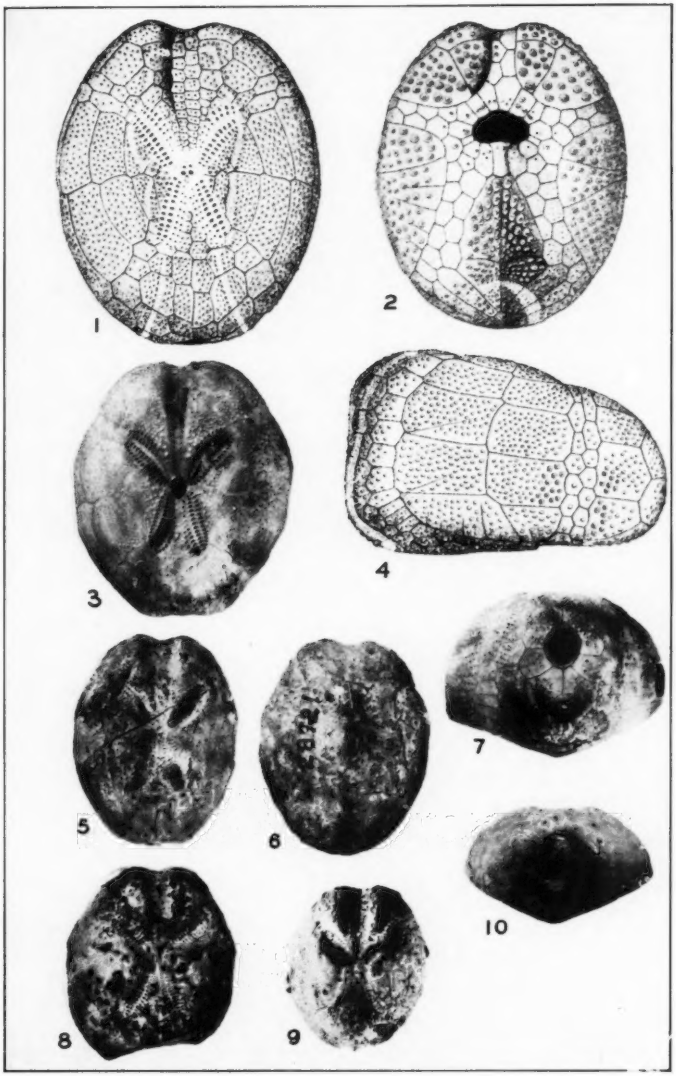
Fig. 7. *Brissopsis luzonica* Gray. Posterior view of specimen shown in fig. 3.

Fig. 8. *Brissopsis blanpiedi* Grant & Hertlein, n. sp. Paratype No. 7172 (Calif. Acad. Sci. Paleo. Type Coll.), from the same locality as the specimen shown in fig. 5. Abactinal view.

Fig. 9. *Brissopsis blanpiedi* Grant & Hertlein, n. sp. Paratype No. 7173 (Calif. Acad. Sci. Paleo. Type Coll.), from the same locality as the specimen shown in fig. 5. Abactinal view.

Fig. 10. *Brissopsis blanpiedi* Grant & Hertlein, n. sp. Posterior view of the specimen shown in fig. 5. Compared to the corresponding view of *Brissopsis luzonica* Gray (fig. 7) the test of the new species is more depressed.

Figs. 1, 2 and 4 are approximately x 3. Fig. 3, 5-9 are approximately natural size.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This new species is similar in general appearance to *Brissopsis luzonica* (Gray) but the petaloid area is smaller and the test more depressed in the fossil form. The height of the test is generally 60% of the length in the case of *B. luzonica* and almost never less than an extreme of 45% even in the case of very flat individuals, whereas the fossils have a height at the posterior end of about 40% of their length.

Remarks.—Brissopsis antillarum Cotteau[8] of the Anguilla formation of the Island of Anguilla and the Cevicos limestone of the Dominican Republic appears from Jackson's figures[9] to resemble the Mississippi species but *antillarum* is much wider and has a greater angle between petals II and IV. The Anguilla formation of the Lesser Antilles and the Cevicos limestone of the Dominican Republic have been considered by some authors to be of Oligocene age but it seems more likely to be Aquitanian Miocene. *Brissopsis jimenoi* Cotteau of the Miocene of Cienfuegos, Cuba, is a more elongate species with longer petals than *blanpiedi*. According to Cotteau's excellent figures,[10] *jimenoi* further differs in that the petals of the bivium are not confluent proximally as they are in the Mississippi species. *B. blanpiedi* has considerable resemblance to *Brissopsis atlantica* Mortensen[11] a Recent Atlantic species. *B. atlantica* is generally wider, its petals are more curved, and it reaches a larger size than any of our specimens of *blanpiedi*.

Holotype No. 7171, and partypes Nos. 7172, 7173 (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 28721 (C.A.S.), four foot bentonite bed which overlies basal manganiferous zone of the Bucatunna which latter rests on Glendon or Marianna limestone: NW corner of NE¼ of Sec. 32, T. 4 N., R. 8 E., Smith County, Mississippi, about 8 miles north of Raleigh, Mississippi. Outcrop 200 yards east of highway No. 35 on Glaze farm.

So far as we are aware, this is the only unquestionable Tertiary species of *Brissopsis* reported from the North American mainland, *Brissopsis rimulatus* Ravenel[12] probably not belonging to this genus.

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8 Kongl. Sven. Vet. Akad. Handl. **13**(6):37, pl. 6, figs. 19-25, 1875.

9 Carnegie Inst. Washington Pub. **306**:82-83, pl. 14, figs. 3, 4, 1922.

10 Ann. Soc. Géol. Belgique **9**:33-35, pl. 3, figs. 5-9, 1881. "Cienfuegos, San Martin (Cuba). Rare. Miocene."

11 *Brissopsis atlantica* Mortensen, Danish Ingolf-Exped. **4**(2), Echin. (II): 160-163, pl. 3, figs. 6, 10, 17, 1907. Bathymetric range, 68-1434 fathoms, East American Atlantic littoral, arch benthal and abyssal regions.

12 Echinidae, Recent and Fossil, of South Carolina: 4, pl. 2, figs. 3 and 4, 1848.

UNIVERSITY OF CALIFORNIA AT LOS ANGELES
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Book Reviews

A LEAF KEY TO FLORIDA BROAD-LEAVED TREES, Native and Exotic, except Palms. By Mary Franklin Barrett. The Author, 57 Union St., Montclair, N. J., 1937. 79 pp., pls. 1-8 on pp. 61-68. Paper bound, $1.00, postpaid.

Since trees form such a conspicuous element in the landscape of any area where they occur they obviously attract the attention of even the uninitiated more readily than other vegetational elements do. Moreover people frequently wish to determine the trees from leaves alone or twigs and are in want of small guides to care for such miscellaneous botanical interests. The present booklet is designed to meet such needs as far as the trees of Florida are concerned, both native and naturalized as well as exotic but under the exclusion of the Conifers, Palms and very rare broad-leaved trees. It tries to accomplish this aim by the use of relatively simple dichotomous keys, by illustrating important characteristics and by showing the leaves of characteristic species of certain genera. Scientific names with certain synonyms, common names and the names of the families to which the species belong are all found in a carefully prepared index. Since Small's "Manual of the Southeastern Flora" is the principal source of information, the treatment of many groups differs from more widely accepted ones, what may also be said of the nomenclature employed. Such terms as "unstipuled" may be convenient but are certainly not commendable. Nor is the practice of mixing phyllotaxy with the morphological description of the leaves very desirable, e.g. "leaves simple, spiral, pinnately veined," etc. Despite such flaws the booklet will be of service on many occasions.—TH. JUST.

TREES OF NORTHEASTERN UNITED STATES, Native and Naturalized. By H. P. Brown. Revised and enlarged edition. The Christopher Publishing House, Boston, 1938. 490 pp., 77 figs., 152 pls. $3.00.

All those who used the author's "Trees of New York State" are readily acquainted with the valuable information brought together in that book and will welcome the present edition enlarged both in scope and area covered.

Introductory chapters are concerned with the "Taxonomy of Plants," "Dendrology," and "Special Morphology" and are followed by excellent keys to leaves, fruits, and twigs which make possible the identification of trees in every season. The "Plates with Legends and Tabulated Descriptive Information" comprise the bulk of the book (pp. 85-393) and are its most valuable part. Appended is a "Conspectus" of the families and genera to which the species treated belong. Very helpful to the general reader will be the chapter on "Derivation of the names of trees" (with a glossary of such) and a "Glossary" of terms.

Not intended to replace "tree" manuals of a more comprehensive character the present volume will fill a definite need and is destined to find wide use and appreciation. —TH. JUST.

KNOWING YOUR TREES. By G. H. Collingwood. The American Forestry Association, Washington, D. C., 1937. 109 pp. $1.00.

Growing public interest constantly demanded information on trees which was met by "American Forests" since October, 1932, by the publication of articles in each issue on one tree species. The first 50 of these have now been brought together, revised in accordance with the most recent knowledge and issued as a handsome volume. Nearly all species are illustrated by photographs of an entire tree, flowers, fruits, leaves, twigs, bark, and their distribution is indicated on maps. Further volumes will be issued from

time to time. Those who use the present volume will await with much expectation its forthcoming companions. The low cost, the full treatment afforded each species, and the beautiful appearance of the book and illustrations will recommend it widely and ensure its popularity.—TH. JUST.

GUIDE TO EASTERN FERNS. By Edgar T. Wherry. Illustrated with line drawings by Olive Stoner and Cyrus Feldman. The Science Press Printing Company, Lancaster, Pa., 1937. iv + 220 pp. $1.00.

While there are many fern books available not all are entirely free from errors, and of a size convenient enough for field use. The present volume was prepared to overcome these difficulties by correct descriptions yet sufficiently non-technical to ensure wide usage and by the inclusion of reliable data regarding habitat, range, and remarks to assist in the identification of related species. Although primarily devoted to the ferns and fern allies (approximately 100) of the area extending between Pennsylvania and New Jersey to Virginia their wider distribution will permit the ready use of the "Guide" in other states. The drawings are as a whole very satisfactory and will add much to the popularity of the "Gide." The same may be said of the chapters on "Fern Cultivation," "Growing Ferns from Spores," and the "Glossary of Technical Terms." The book will no doubt find many friends and its dependable information will assist greatly in eliminating certain popular misconceptions.—TH. JUST.

PLANTS OF ZION NATIONAL PARK. By C. C. Presnall, assisted by Pauline Mead Patraw. Zion-Bryce Museum Bulletin No. 1, Zion National Park, Utah, 1937. 69 pp., 15 pls., 3 photographs, 12 figs. Lithoprinted, $ .50.

Many tourists find themselves bewildered when arriving at a National Park and consequently ask the guides many questions pertaining to the natural history of the area concerned. It is therefore not surprising that the Park Services should attempt to present various phases of the natural history of these parks in simple and handy form for the benefit of those who wish to learn more about them than a short stay can provide. The present booklet seems to meet these conditions well by describing the plants found in the Zion National Park with keys for their identification and many useful illustrations (photographs and drawings).—TH. JUST.

A COMMENTARY ON THE LAWS OF BOTANICAL NOMENCLATURE. By C. X. Furtado. The Gardens' Bulletin, Straits Settlements, **9**(3):223-284, October 9th, 1937.

THE NOMENCLATURE OF TYPES. By C. X. Furtado. Loc. cit., pp. 285-308. $2.00.

With the increasing use of the International Rules of Botanical Nomenclature it becomes more and more necessary to pause from time to time and take account of their actual usefulness and unequivocal applicability. Not objecting to the acceptance of the Rules the author nevertheless does find many difficulties in them which he points out and which he attempts to remedy by the proposal of relevant measures. Obviously space does not permit here a detailed discussion of his suggestions but botanists interested in nomenclatorial problems in more than a passing manner will want to study them. —TH. JUST.

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